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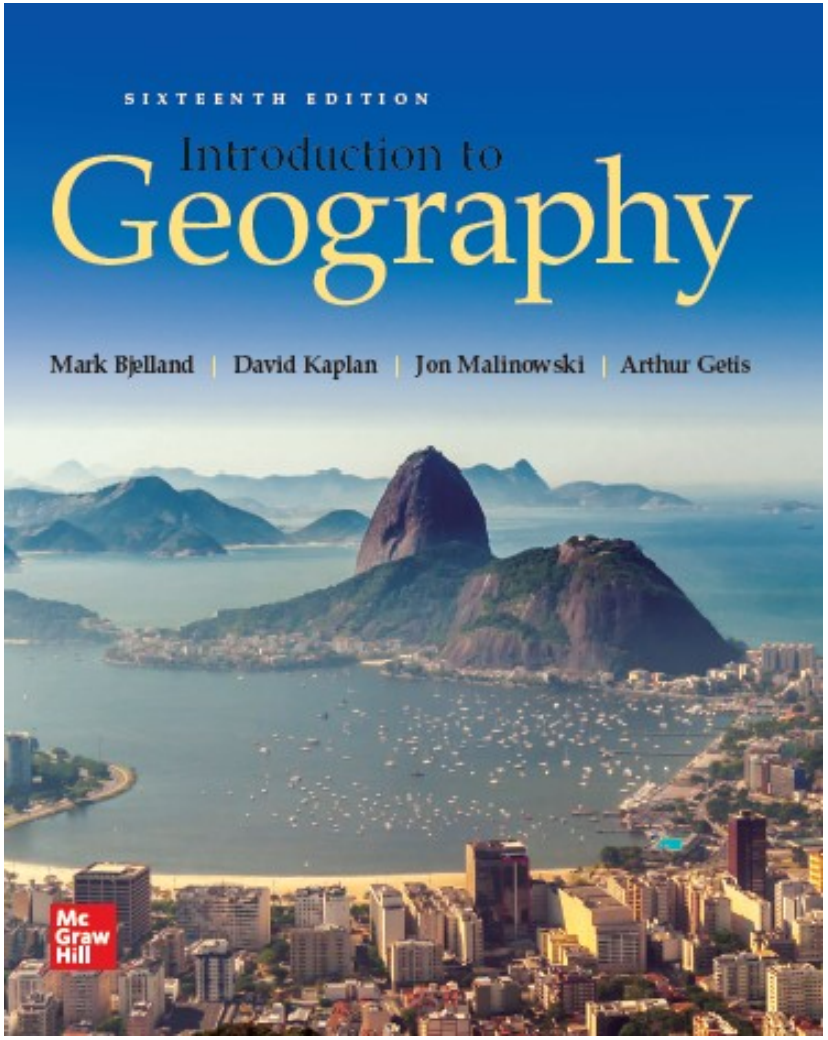
# Introduction to Geography

Mark Bjelland, David Kaplan, Jon Malinowski, Arthur Getis

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# Geographic Techniques and Skills

Chapter 2

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# Overview

- Maps as the Tools of Geography.
- Locating Points on a Sphere.
- Map Projections.
- Scale.
- Types of Maps.
- Contemporary Spatial Technologies.
- Integrating Technology: Geographic Information Systems.

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# Maps as the Tools of Geography

Maps are the primary tools of spatial analysis

## Cartography

- The art, science and technology of making maps

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# Locating Points on a Sphere
# The Geographic Grid (1)

Set of imaginary lines that intersect at right angles to form a system of reference for locating points on the surface of the earth

Key reference points

- **North and South Poles, equator, prime meridian**

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# Locating Points on a Sphere
# The Geographic Grid (2)

## Latitude

- Angular distance **north** or **south** of the **equator**
  - Measurements ranging from **0° (equator) to 90°** (poles)
- **Parallels of latitude** are **parallel** to each other and run east-west
- Parallels decrease in length as one nears the poles
- Distance between each degree of latitude ≈ 69 miles
  - Due to slight flattening of Earth in polar regions, degrees of latitude are slightly longer near the poles than near the equator

© McGraw Hill

# Locating Points on a Sphere
# The Geographic Grid (3)

## Prime Meridian

- Starting point for **east-west** measurement
- Passes through **Greenwich, England**

## Longitude

- Angular distance **east** or **west** of the **prime meridian**
  - Measurements range from **0° (prime meridian) to 180°**
- Meridians are ***farthest apart at the equator*** **and** ***converge at the poles***
- All **meridians** are the **same length**
- For more locational precision, *a* ***degree*** *can be subdivided into* ***minutes*** *and* ***seconds****.*

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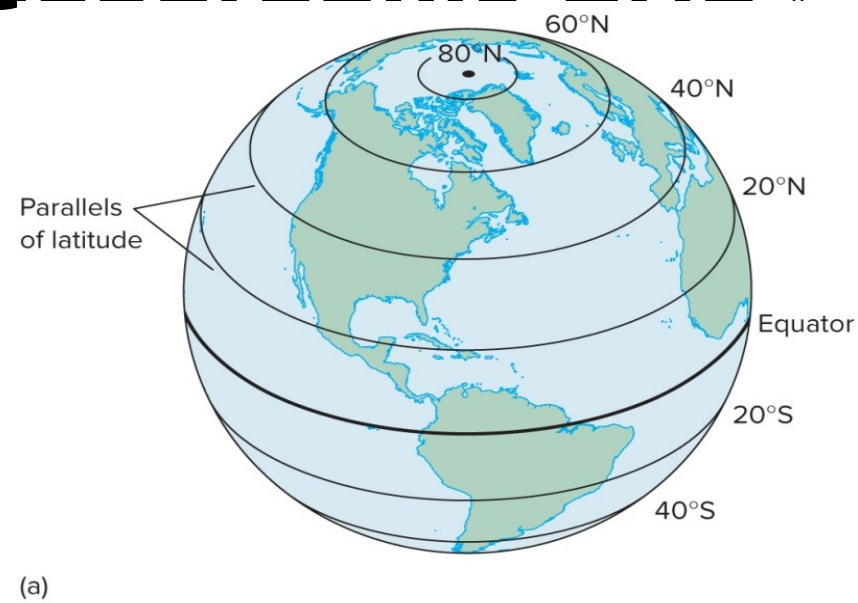
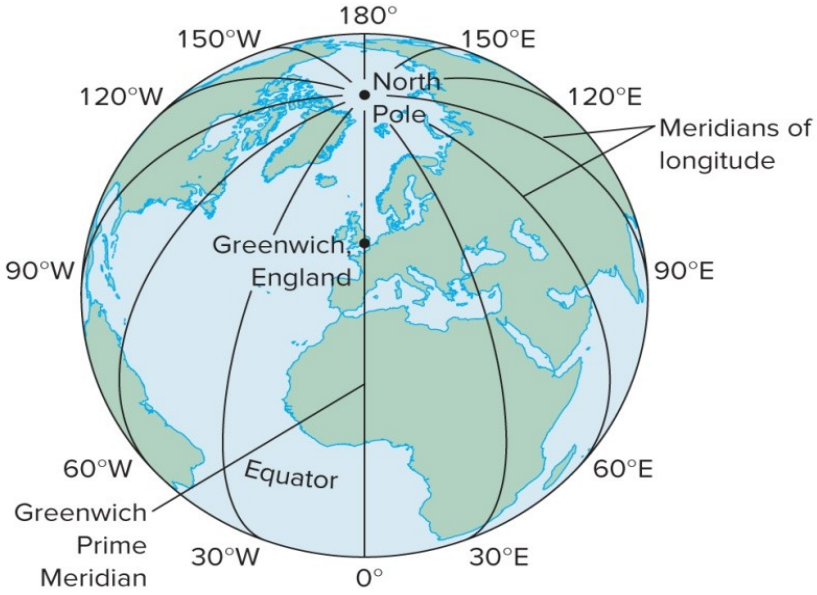
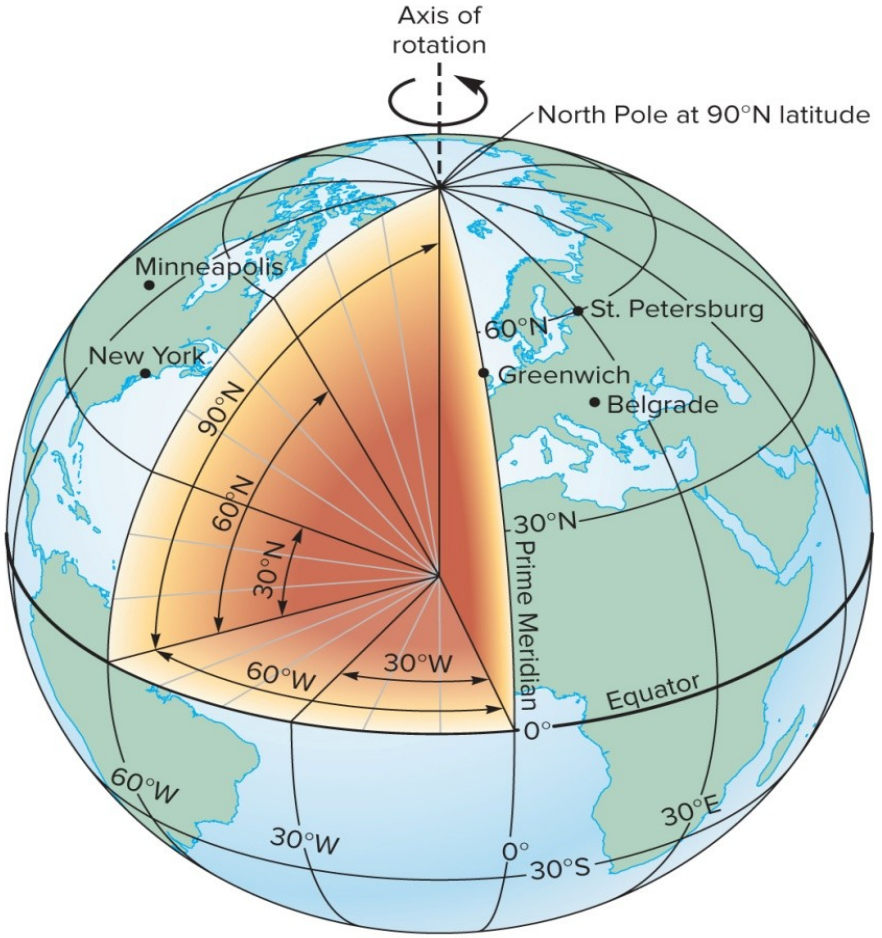
# Locating Points on a Sphere The Geographic Grid




(a)




(b)




(c)

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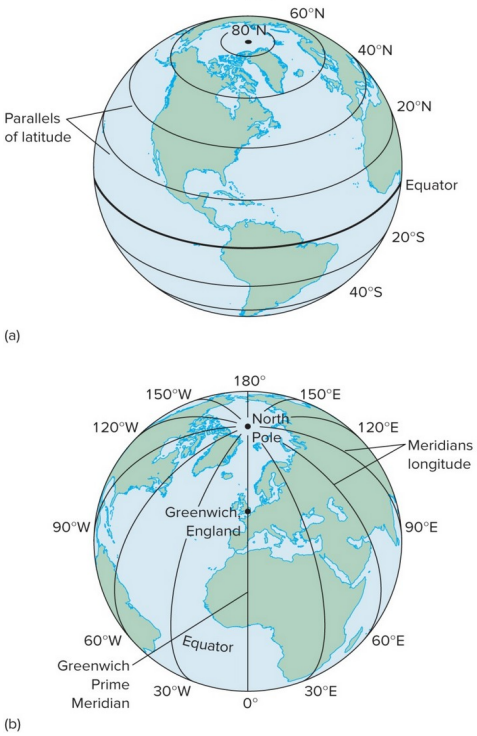
# Locating Points on a Sphere

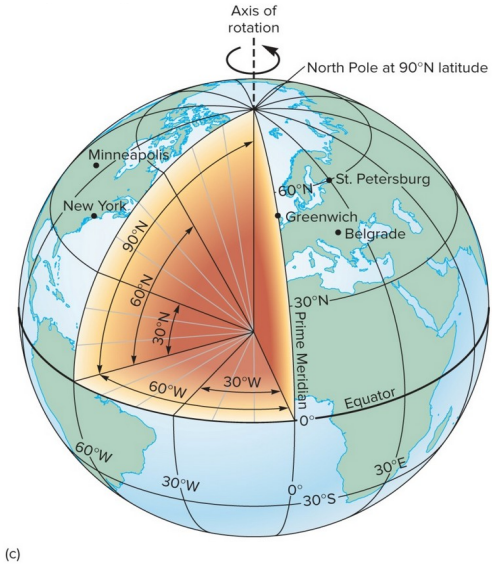
# The Geographic Grid (4)

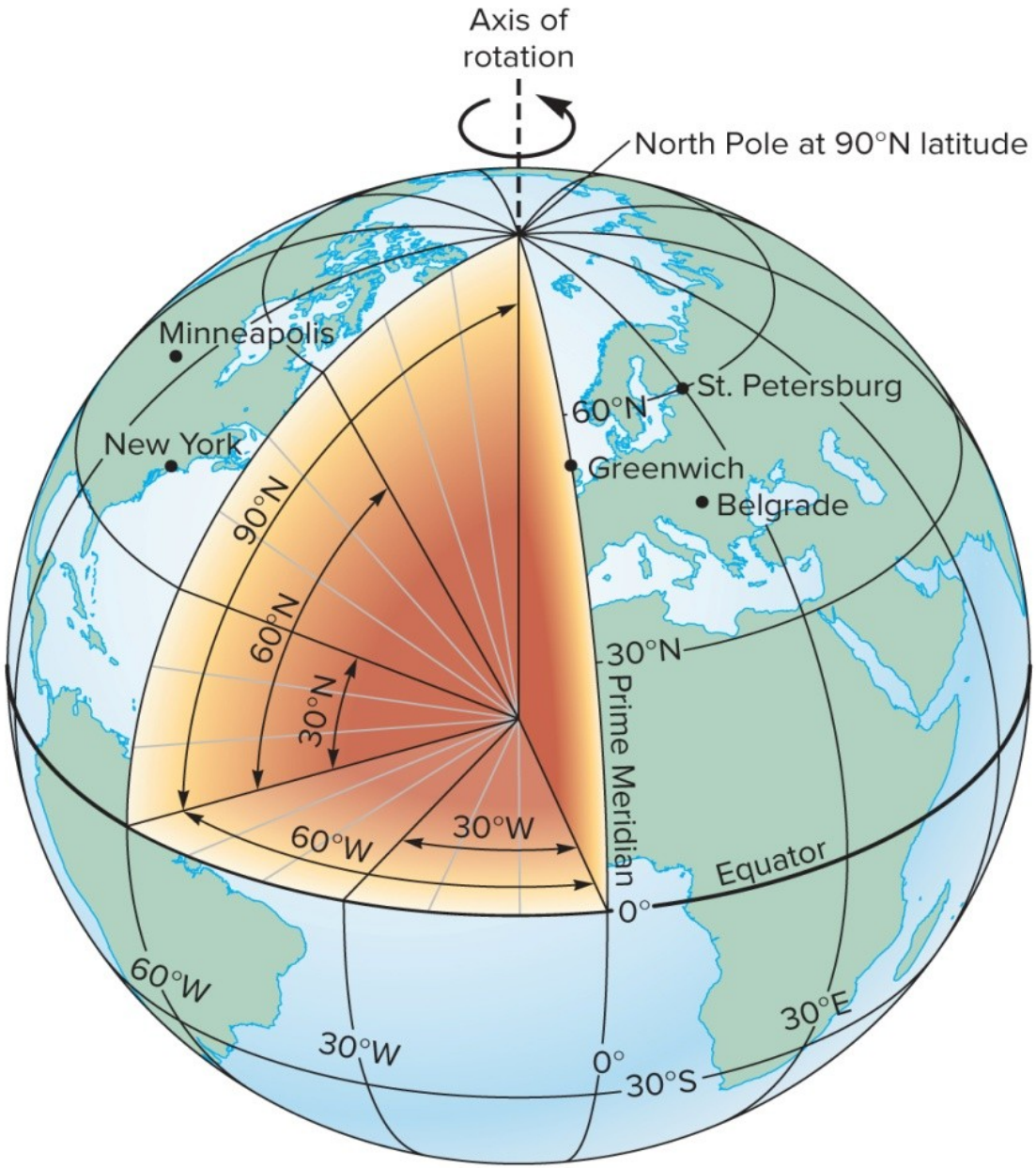
a) The grid system: **parallels of latitude**. Note that the parallels become increasingly shorter closer to the poles. On the globe, the 60th parallel is only one-half as long as the equator.

b) The grid system: **meridians of longitude**. East-west measurements range from 0° to 180°—that is, from the prime meridian to the 180th meridian in each direction. Because the meridians converge at the poles, the distance between degrees of longitude becomes shorter as one moves away from the equator.

c) The Earth grid, or graticule, consisting of parallels of latitude



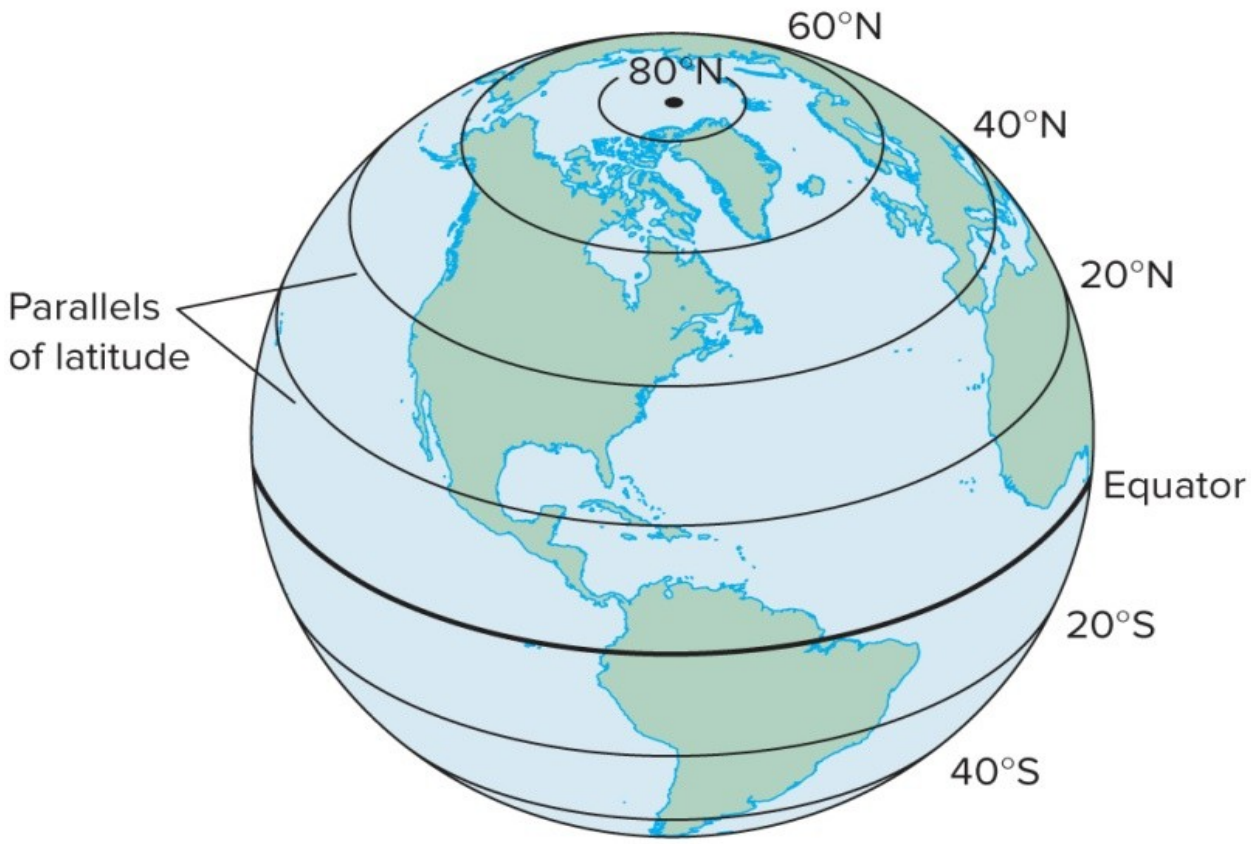





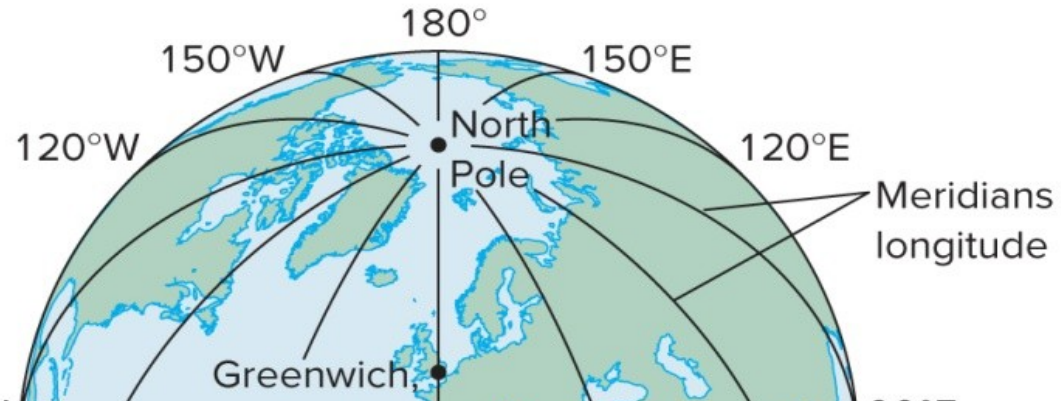

(c)

The Earth grid, or graticule, consisting of **Parallels of Latitude** and **Meridians of**

a)The grid system: **Parallels of Latitude**. Note that the **parallels become increasingly shorter** closer to the poles. On the globe, the 60th parallel is only one-half as long as the equator.




(a)

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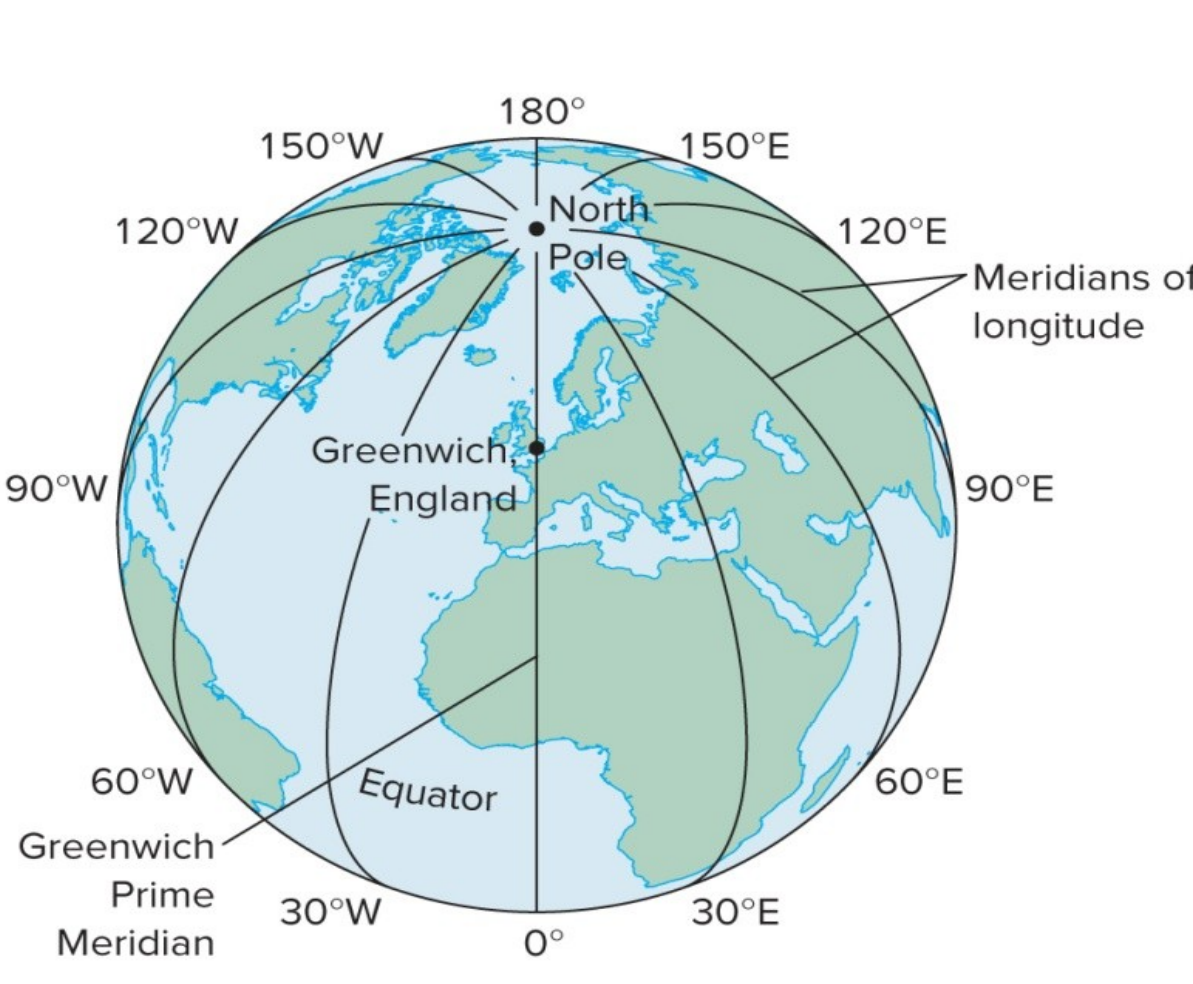
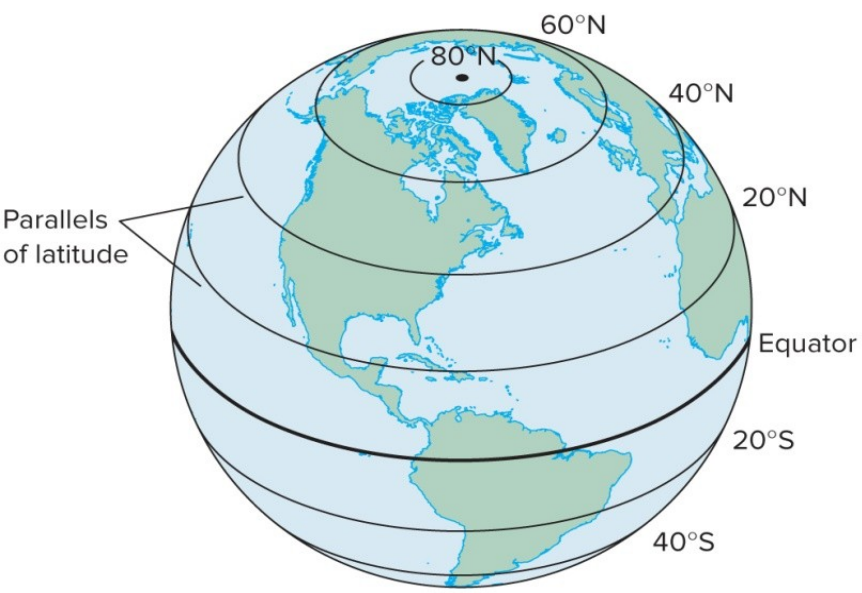
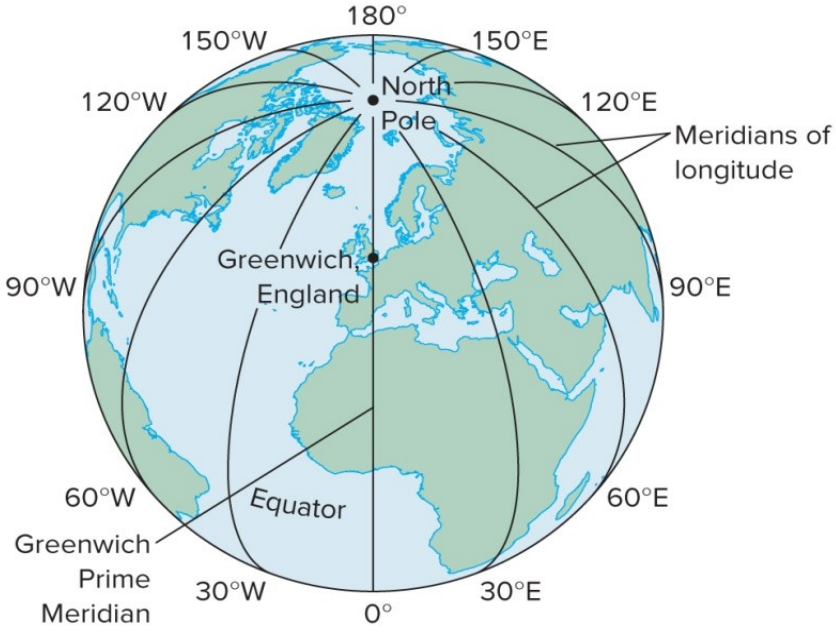
a)The grid system: M**eridians of Longitude**. East-west measurements range from **0° to 180°**—that is, from the **Prime Meridian to the 180th meridian in each direction.** Because the meridians converge at the poles, the **distance between degrees of**






(a)

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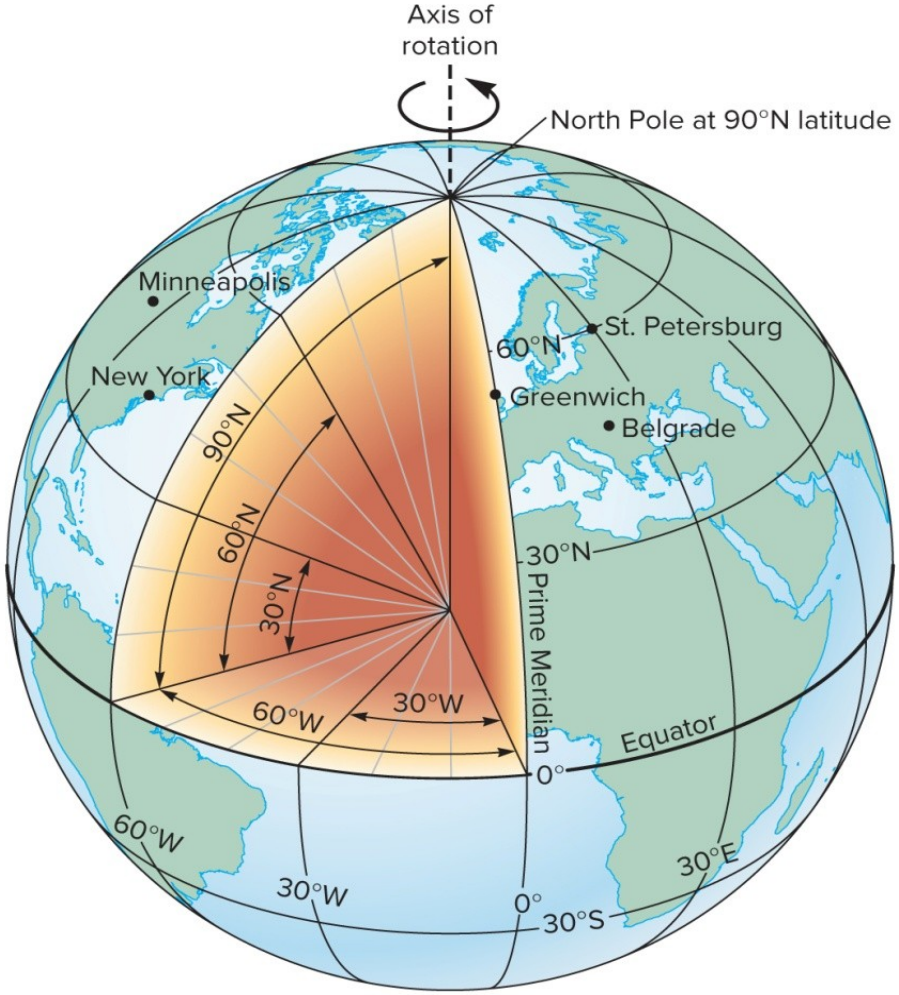


(c)

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# 5. Global Time

## Precise Timekeeping

**Precise timekeeping** – Most accurate form of timekeeping using atomic clocks

- Based on the frequency of microwave energy emission from atoms of the element cesium cooled to near absolute zero
- Keeps time to better than one part in 1 trillion

**Coordinated Universal Time (UTC)**

- Universal standard
- Administered by the Bureau International de l'Heure, located near Paris



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# Locating Points on a Sphere
# The Geographic Grid (5)

***(civilian) Time depends on Longitude***

## Greenwich mean time (GMT)

- Time at the prime meridian

**International Date Line**

- Where each new day begins
- Generally follows the **180th meridian**

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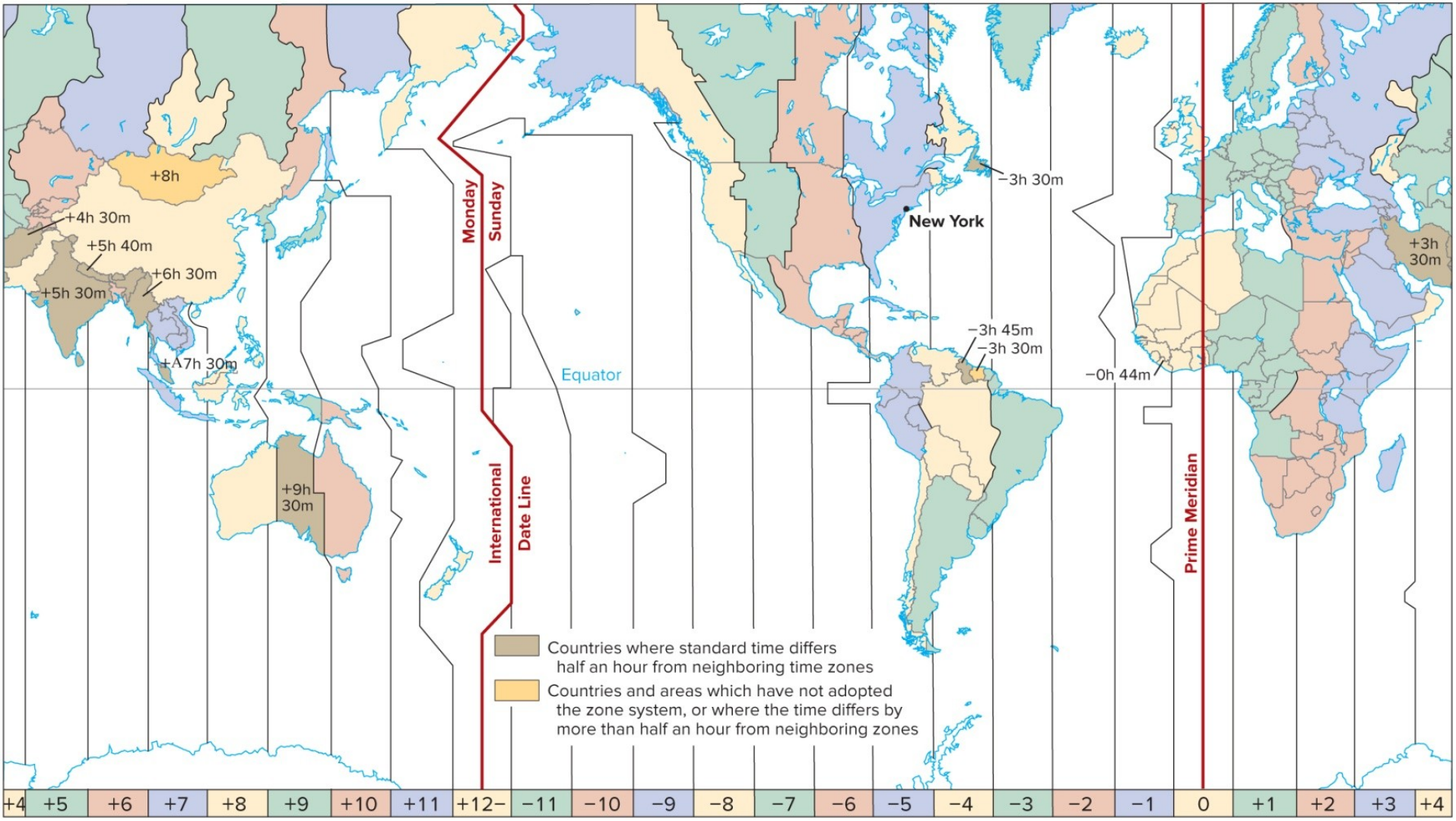
# World Time Zones


+8h
+4h 30m
+5h 40m
+6h 30m
+5h 30m
+7h 30m
+9h 30m
Monday
Sunday
International Date Line
Equator
−3h 30m
New York
−3h 45m
−3h 30m
−0h 44m
+3h 30m
Prime Meridian
Countries where standard time differs half an hour from neighboring time zones
Countries and areas which have not adopted the zone system, or where the time differs by more than half an hour from neighboring zones
+4 +5 +6 +7 +8 +9 +10 +11 +12− −11 −10 −9 −8 −7 −6 −5 −4 −3 −2 −1 0 +1 +2 +3 +4

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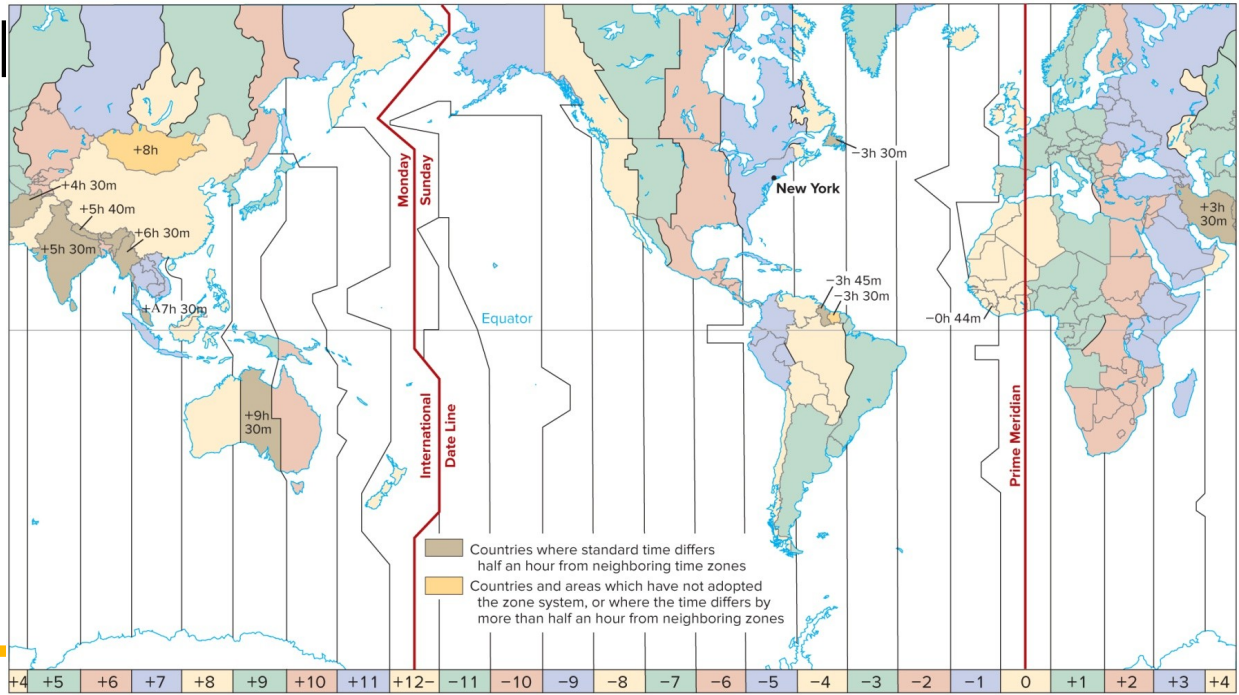
# World Time Zones

**World time zones.** Each time zone is about **15 degrees wide**, but *variations occur to accommodate political boundaries.* The figures at the bottom of the map represent the time difference in hours when it is 12 noon in the time zone centered on Greenwich, England. New York is in column –5, so the time there is 7 a.m. when it is noon at Greenwich


+8h
+4h 30m
+5h 40m
+6h 30m
+5h 30m
+7h 30m
+9h 30m
Monday
Sunday
International Date Line
Equator
New York
−3h 30m
−3h 45m
−3h 30m
−0h 44m
+3h 30m
Prime Meridian
Countries where standard time differs half an hour from neighboring time zones
Countries and areas which have not adopted the zone system, or where the time differs by more than half an hour from neighboring zones
+4 +5 +6 +7 +8 +9 +10 +11 +12− −11 −10 −9 −8 −7 −6 −5 −4 −3 −2 −1 0 +1 +2 +3 +4

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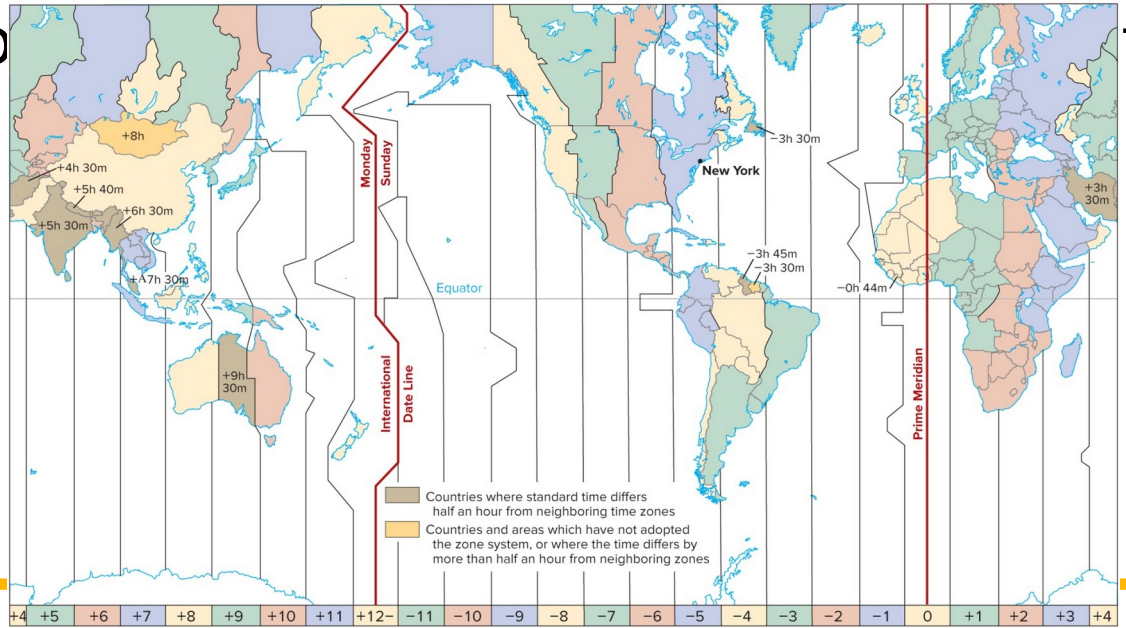
# World Time Zones

**World time zones. Modifications to the universal system of time zones are numerous**. Thus, Iceland operates on the same time as Britain, although it is a time zone away. Spain, entirely within the boundaries of the GMT zone, sets its clocks at +1 hour, whereas Portugal conforms to GMT. China straddles five time zones, but the whole country operates on Beijing time (+8 hours). In South America, Chile (in the –5 hour zone) uses the 24 hour designation, whereas Argentina uses the –3 hour zone instead o tter suited.


+8h
+4h 30m
+5h 40m
+6h 30m
+5h 30m
+7h 30m
+9h 30m
Monday
Sunday
International Date Line
Equator
New York
−3h 30m
−3h 45m
−3h 30m
−0h 44m
+3h 30m
Prime Meridian
Countries where standard time differs half an hour from neighboring time zones
Countries and areas which have not adopted the zone system, or where the time differs by more than half an hour from neighboring zones
+4 +5 +6 +7 +8 +9 +10 +11 +12− −11 −10 −9 −8 −7 −6 −5 −4 −3 −2 −1 0 +1 +2 +3 +4

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# World Time Zones

# Locating Points on a Sphere: Land Survey Systems in the United States

**Township and range system**

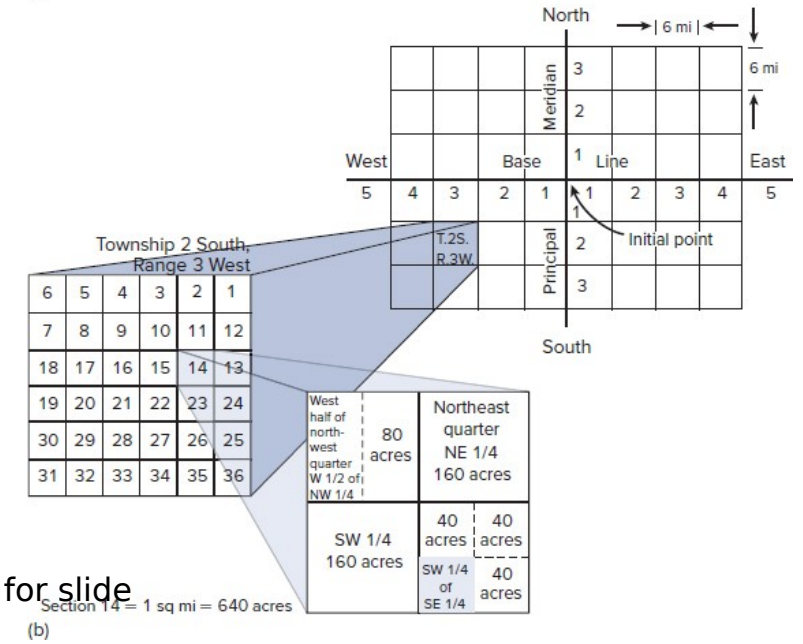
**East-west base lines** and **north-south meridians**.

(a)

Township consists of **36 square miles**

- Further divided into **36 sections of 1 square mile = 640 acres**

Subdivided into **quarter-sections of 160 acres.**




Access the text alternative for slide images.

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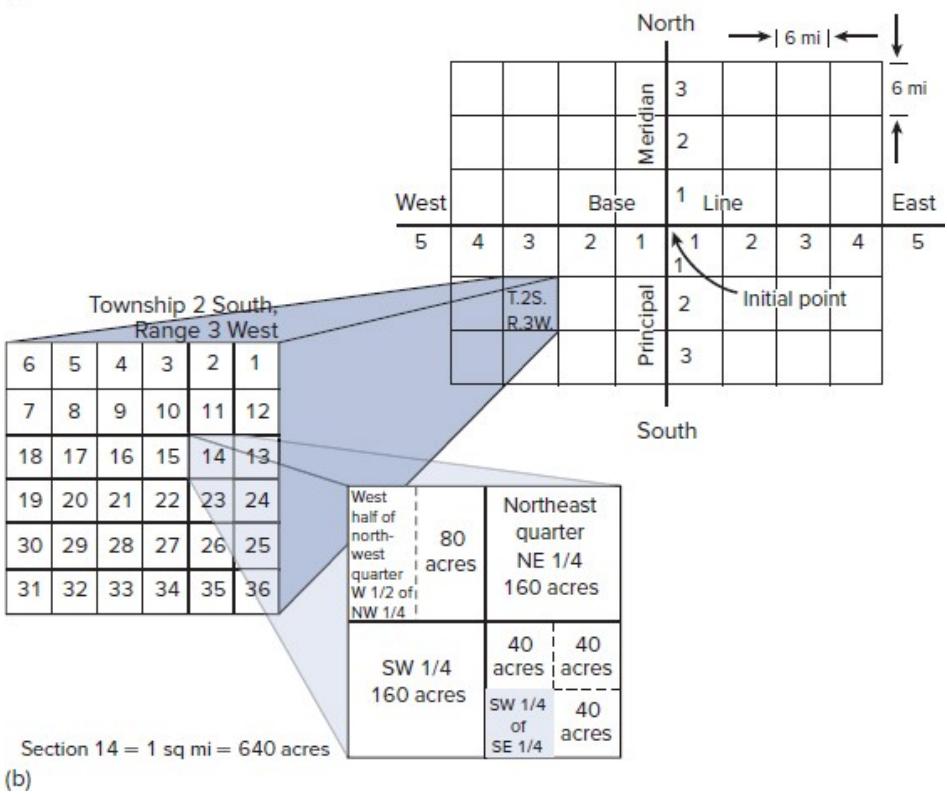
From U.S. Department of the Interior, Bureau of Land Management, Surveying Our Public Lands. Washington, D.C.: U.S. Government Printing Office, 1980

A detailed diagram of **township and range system.** The diagram consists of 3 images. The first image shows coordinate system comprised of the **north south principal meridian versus the east west base line.** The point of intersection is 1. The system is divided into grids which is formed by the **intersection of the meridians (vertical lines) and base line (horizontal lines).** The second image in the diagram is a blow up of a grid from the first image. **The grid is located at 3 south 3 west.** The second image is also a grid with **square block which range from 1 to 36.** The **third image is a blow up of block 14 from image 2. The block is indicated to 1 square mile or**

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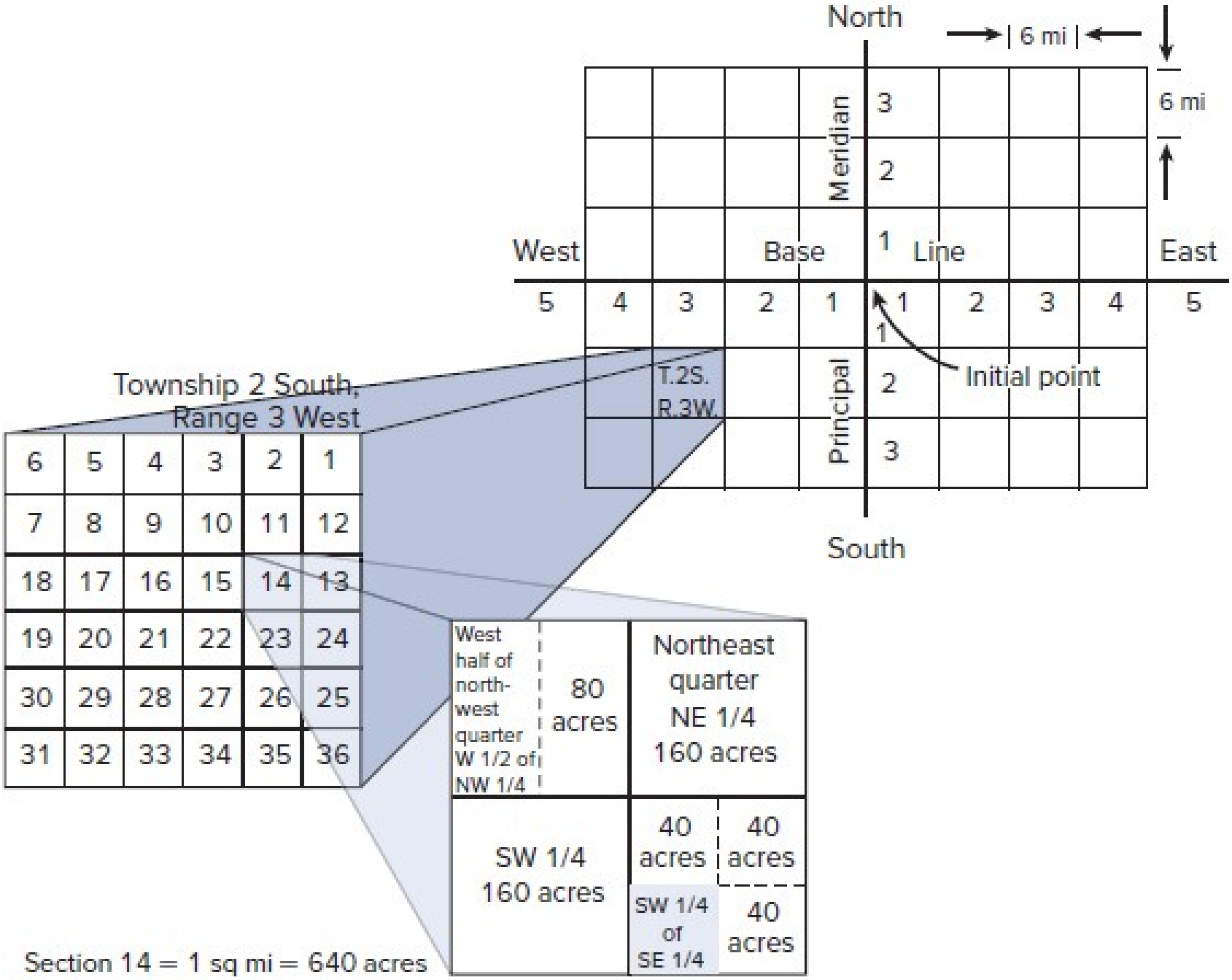


(b)

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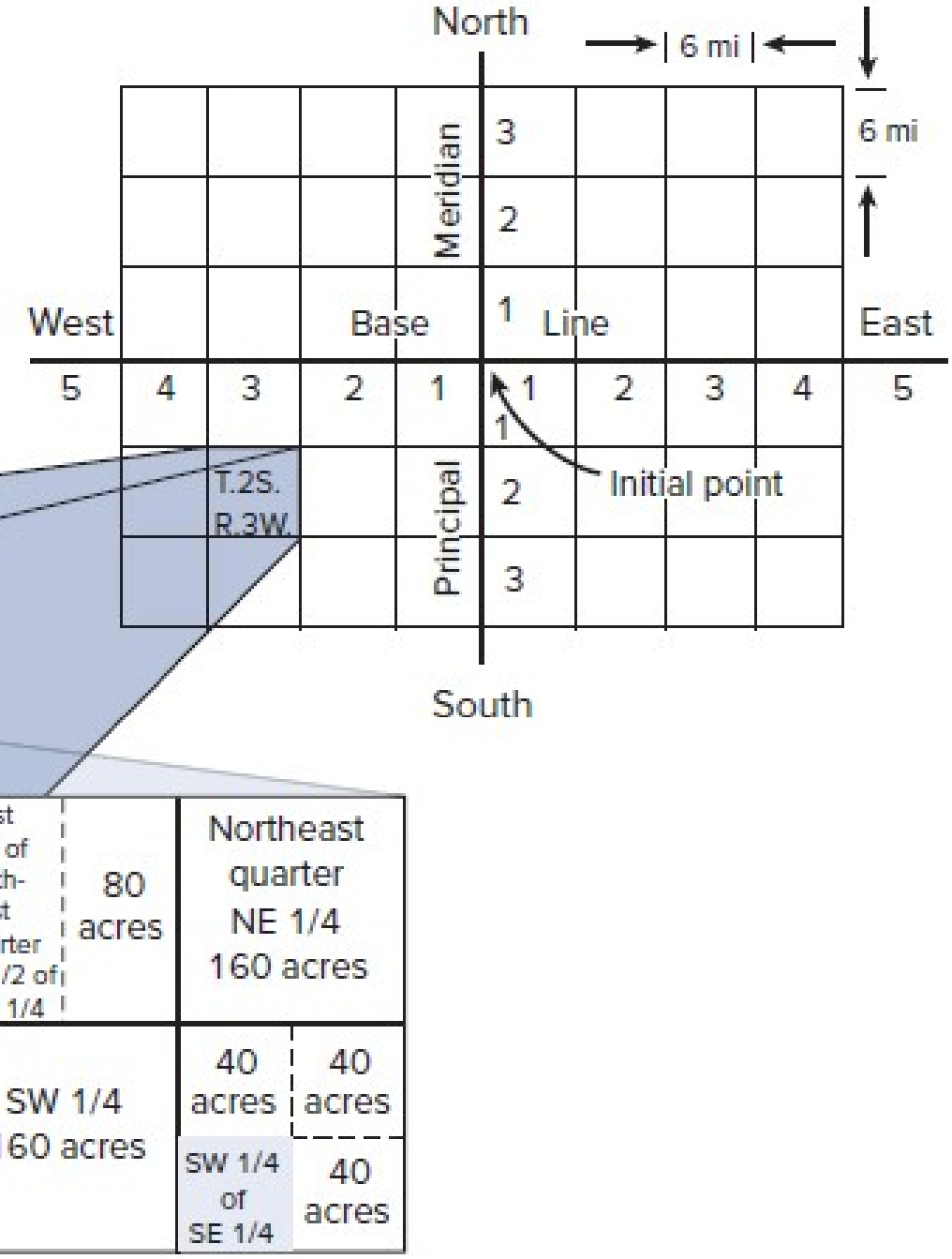


The first image shows coordinate system comprised of the **north south principal meridian versus the east west base line.** The point of intersection is 1. The system is divided into grids which is formed by the **intersection of the meridians**

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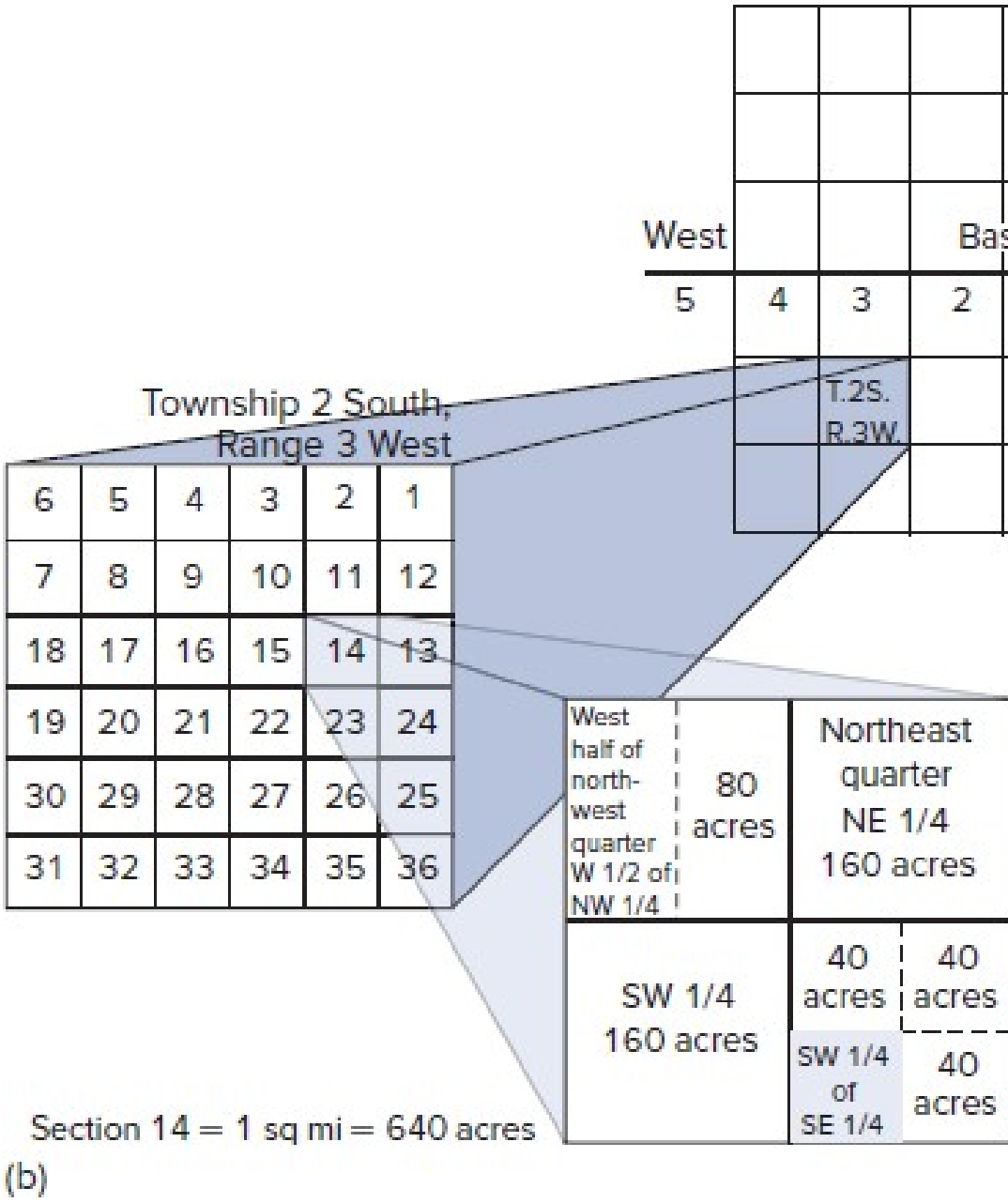
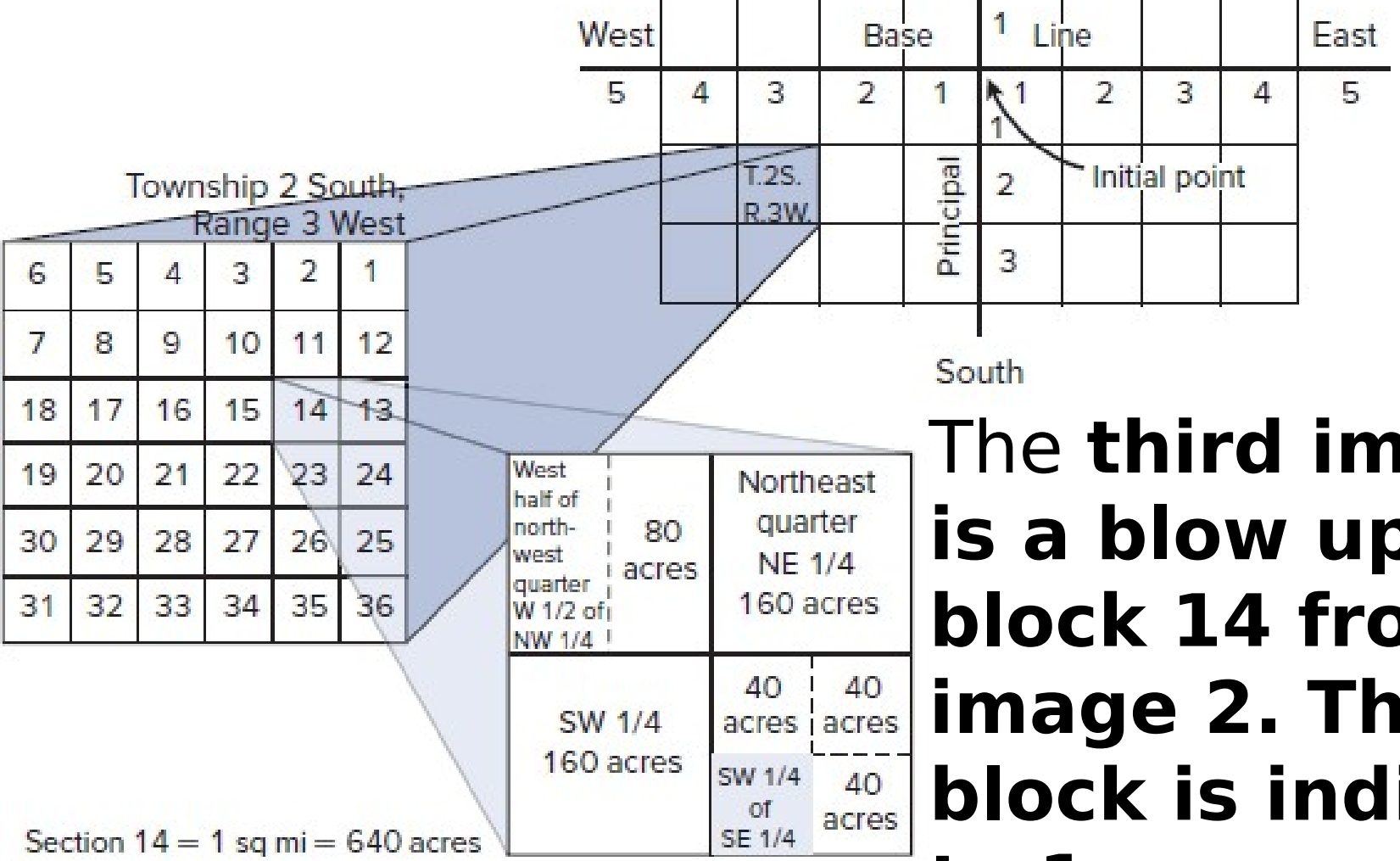
The second image in the diagram is a blow up of a grid from the first image. **The grid is located at 2 south 3 west.** The second image is also a grid with **square block**




© McGraw Hill




The **third image is a blow up of block 14 from image 2. The block is indicated to 1 square mile or 640 acres.** The image shows how the total area is divided into 6

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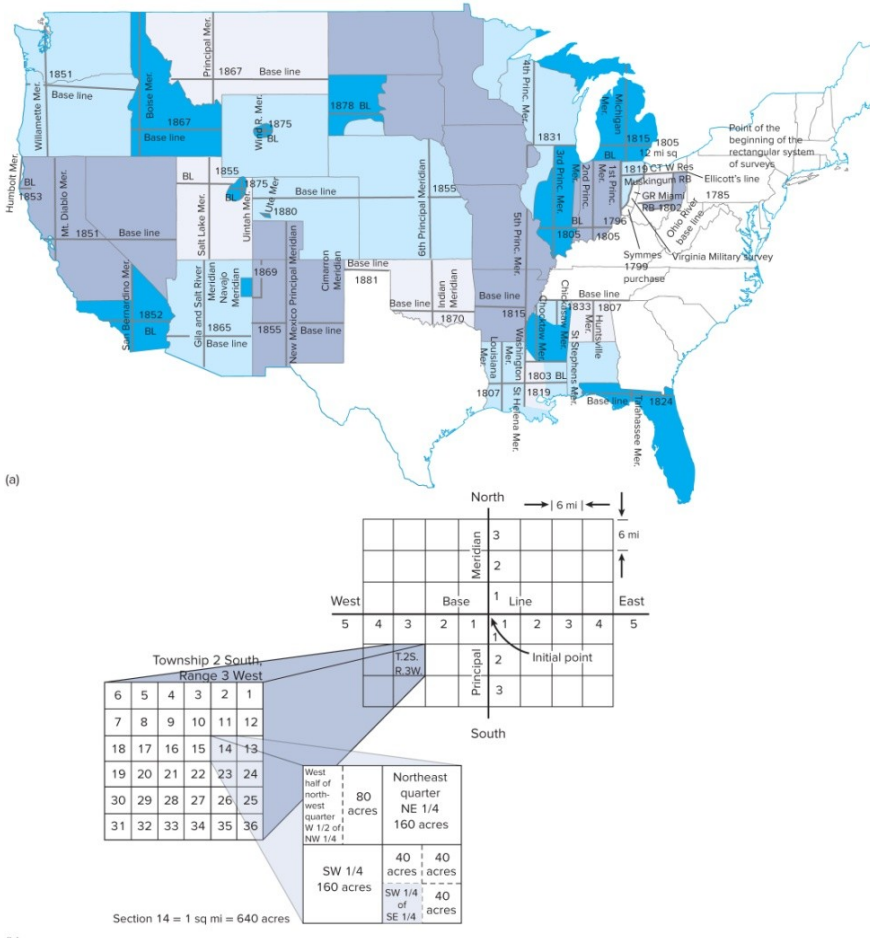
# Locating Points on a Sphere: Land Survey Systems in North America

## Township and range system

- **East-west base lines** and **north-south meridians**
- Township consists of
  - Further divided into **36 sections** of (640 acres)
    - Subdivided into quarter-sections of **160 acres**

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# Locating Points on a Sphere: Land Survey Systems in North America

a) **Principal base lines** and **meridians** governing the U.S. Public Land Survey (USPLS).

b) **Township, section**, and further divisions of the USPLS. The township and range survey system gives each parcel of land a unique identification. **Townships are numbered by rows** (called tiers) and **columns** (called ranges). In the example shown here, the township in the second tier south of the base line and in the third range west of the principal meridian is labeled T.2S, R.3W. **Every township is divided into sections 1 mile** (1.6 km) on a side and **numbered from 1 to 36,** beginning at the northeast corner of the township. Sections can be **divided into quarters, eighths ("half-quarters"),** and **sixteenths ("quarter-quarters").** The Land Office code for the shaded area in the lower right diagram

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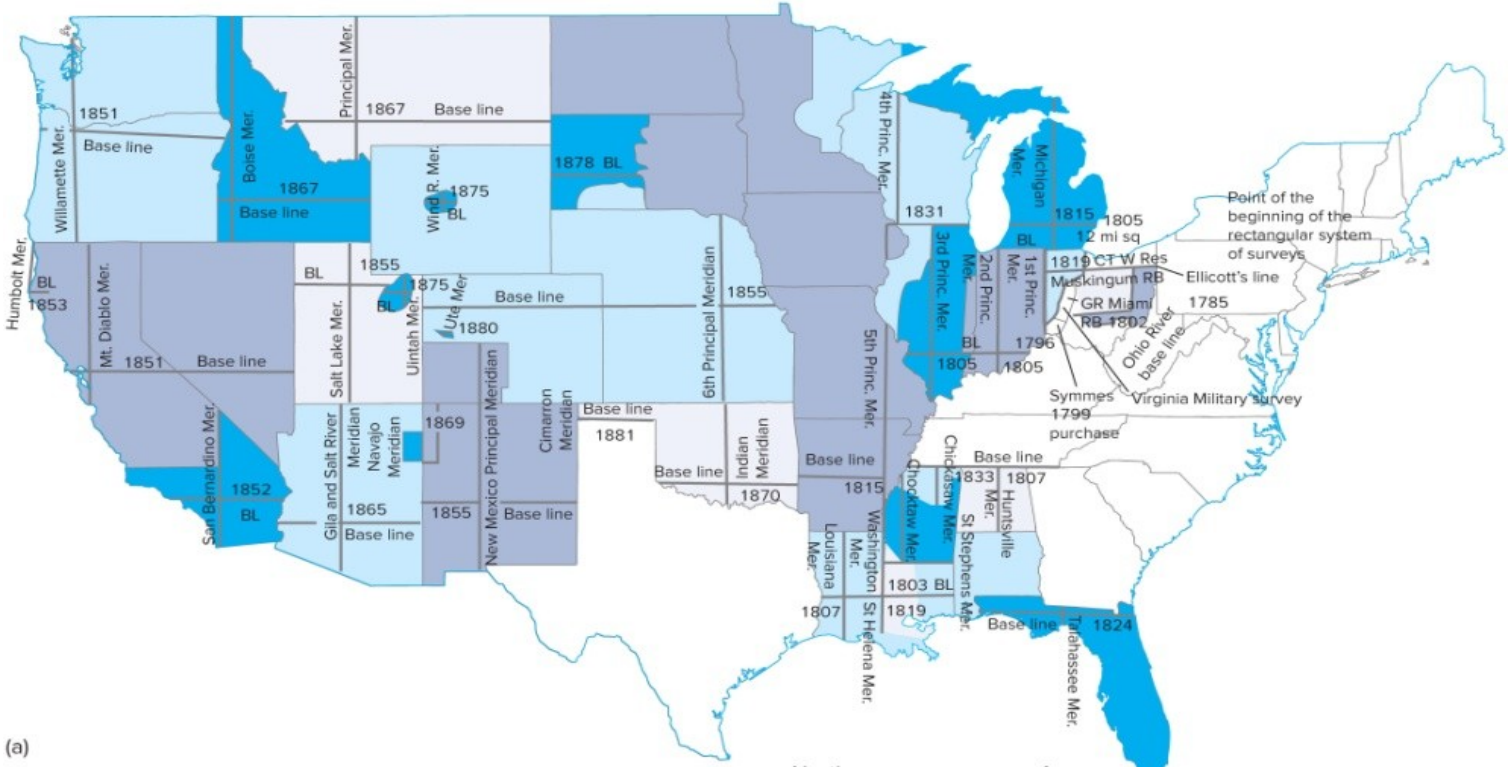
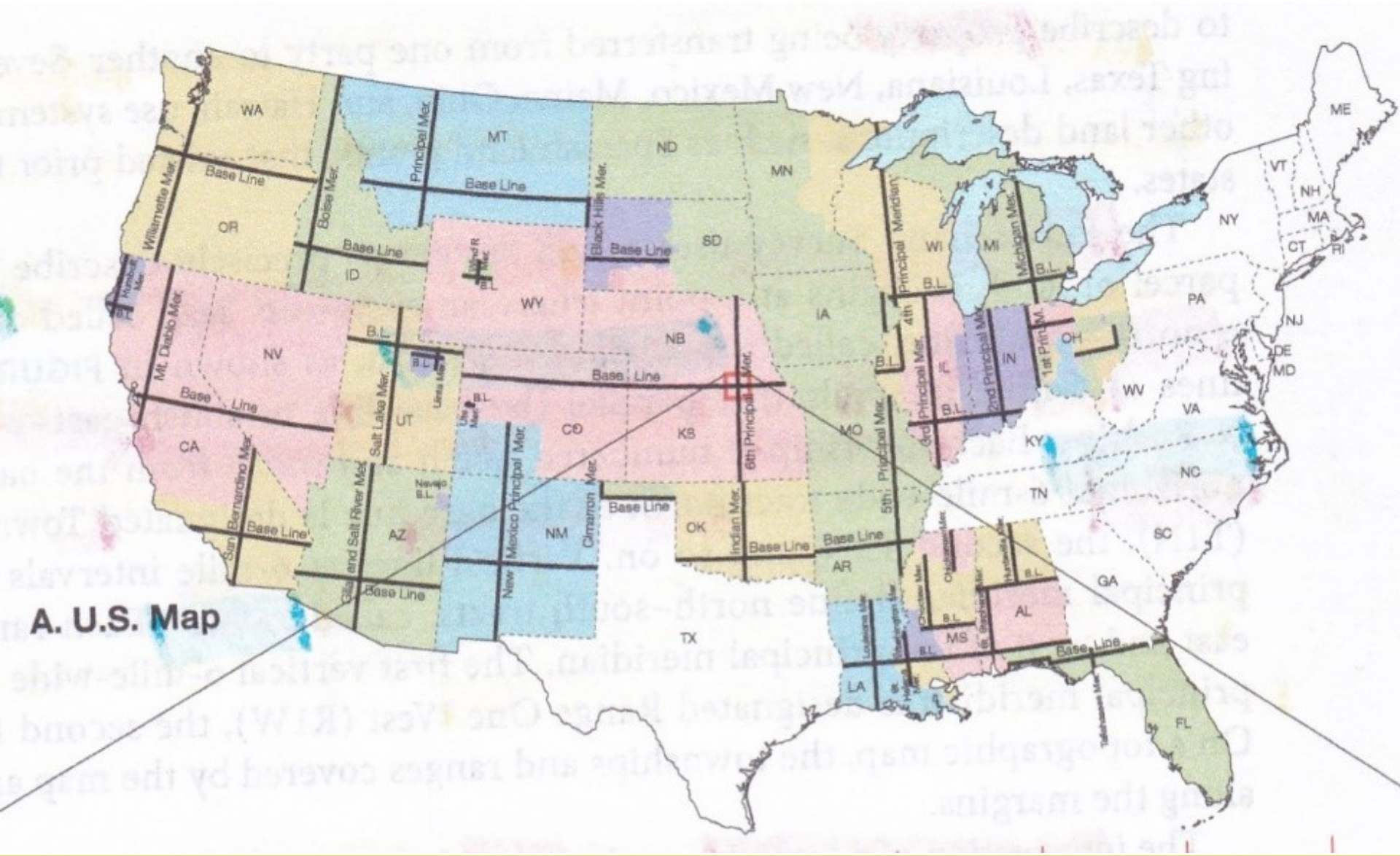

Humboldt Mer.
Willamette Mer.
Base line
1851
Boise Mer.
1867
Principal Mer.
Base line
1867
Base line
Wind R. Mer.
1875
BL
1878 BL
4th Princ. Mer.
1831
Michigan Mer.
1815
1805
12 mi sq
Point of the beginning of the rectangular system of surveys
BL
1853
Mt. Diablo Mer.
1851
Base line
BL
1855
Salt Lake Mer.
BL
1875
Ute Mer.
Base line
1880
Uintah Mer.
1855
6th Principal Meridian
3rd Princ. Mer.
2nd Princ. Mer.
1st Princ. Mer.
BL
1819 CT W Res
Muskingum RB
Ellicott's line
GR Miami
RB 1802
1785
1796
1805
1805
5th Princ. Mer.
Ohio River base line
Symmes 1799 purchase
Virginia Military survey
San Bernardino Mer.
1852
BL
Gila and Salt River Meridian
Navajo Meridian
1869
1865
Base line
Cimarron Meridian
New Mexico Principal Meridian
1855
Base line
Base line
1881
Indian Meridian
1870
Base line
1815
Chickasaw Mer.
Base line
1833
1807
Huntsville
St Stephens Mer.
Louisiana Mer.
Washington Mer.
1803 BL
1807
St Helena Mer.
1819
Base line
1824
Tallahassee Mer.
(a)
North
6 mi
6 mi
Meridian
3
2
1
West
Base
Line
East
5 4 3 2 1 1 2 3 4 5
1
2
3
Initial point
T.2S.
R.3W.
Principal
South
Township 2 South, Range 3 West
6 5 4 3 2 1
7 8 9 10 11 12
18 17 16 15 14 13
19 20 21 22 23 24
30 29 28 27 26 25
31 32 33 34 35 36
West half of northwest quarter W 1/2 of NW 1/4
80 acres
Northeast quarter NE 1/4 160 acres
SW 1/4 160 acres
40 acres
40 acres
SW 1/4 of SE 1/4
40 acres
Section 14 = 1 sq mi = 640 acres

© McGraw Hill

# Township and range syste

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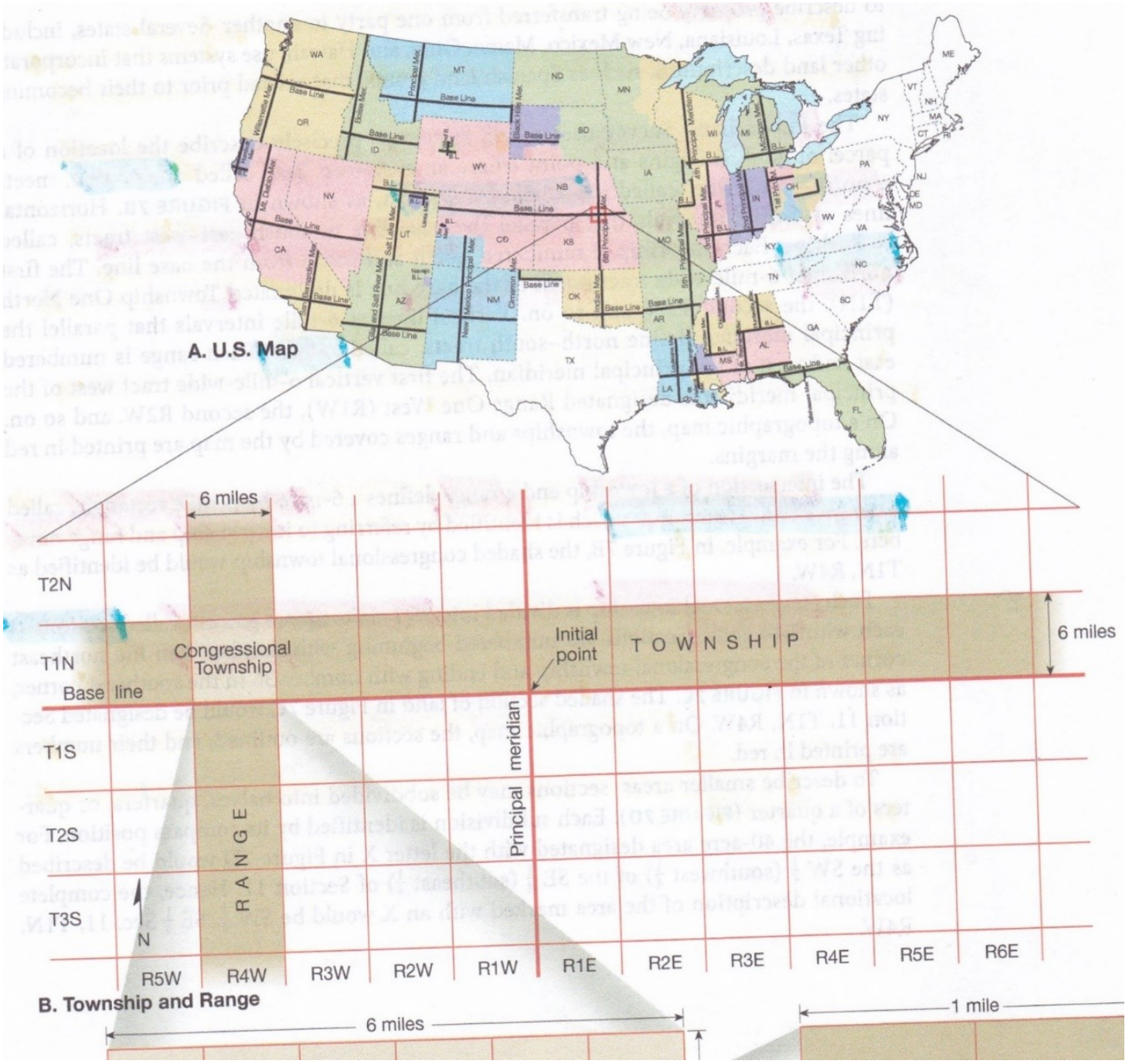
A. U.S. Map
6 miles
T2N
T1N
Base line
Congressional Township
Initial point
TOWNSHIP
6 miles
T1S
T2S
T3S
N
RANGE
Principal meridian
R5W
R4W
R3W
R2W
R1W
R1E
R2E
R3E
R4E
R5E
R6E
B. Township and Range
6 miles
1 mile

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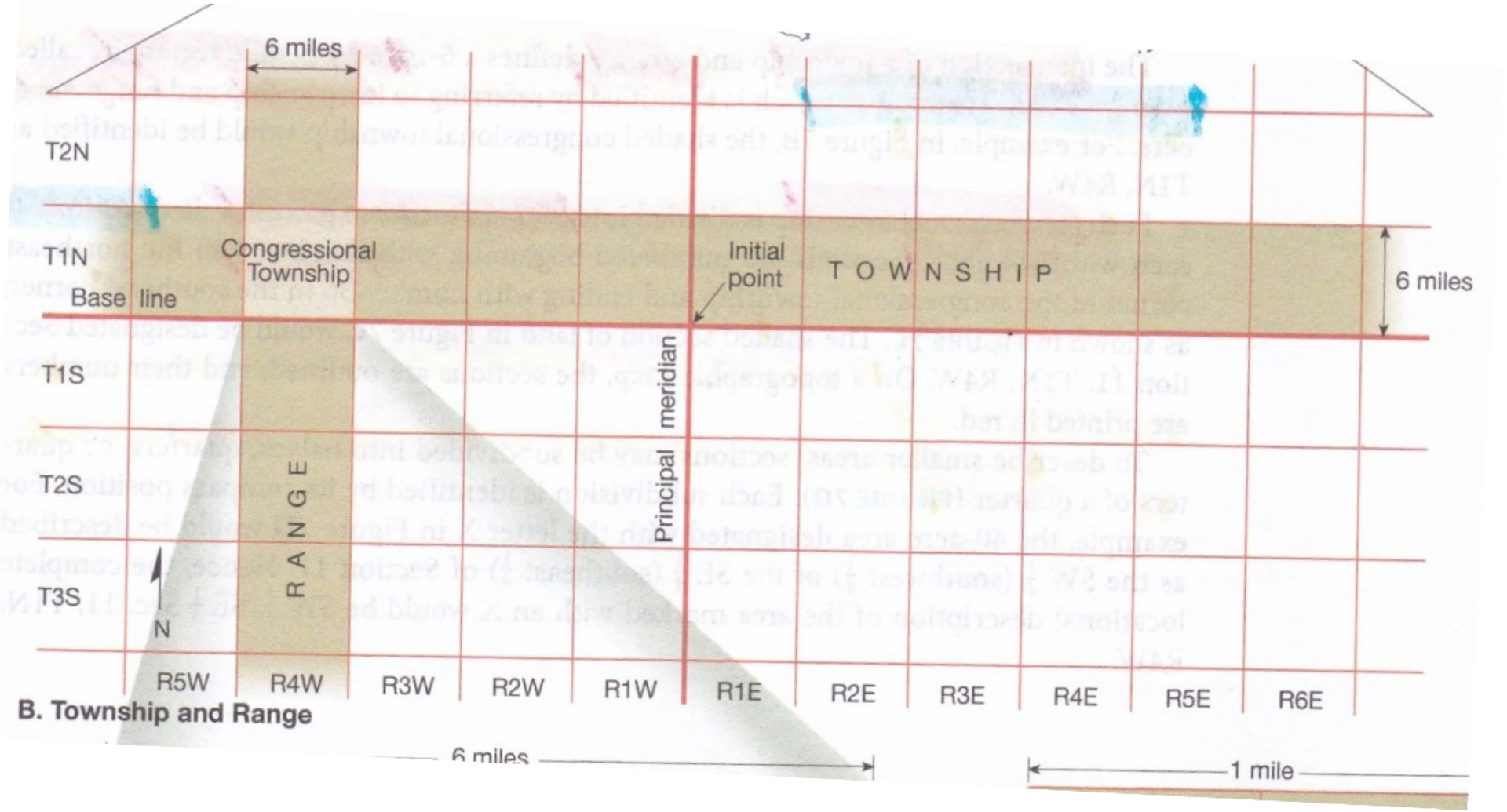


**B. Township and Range**

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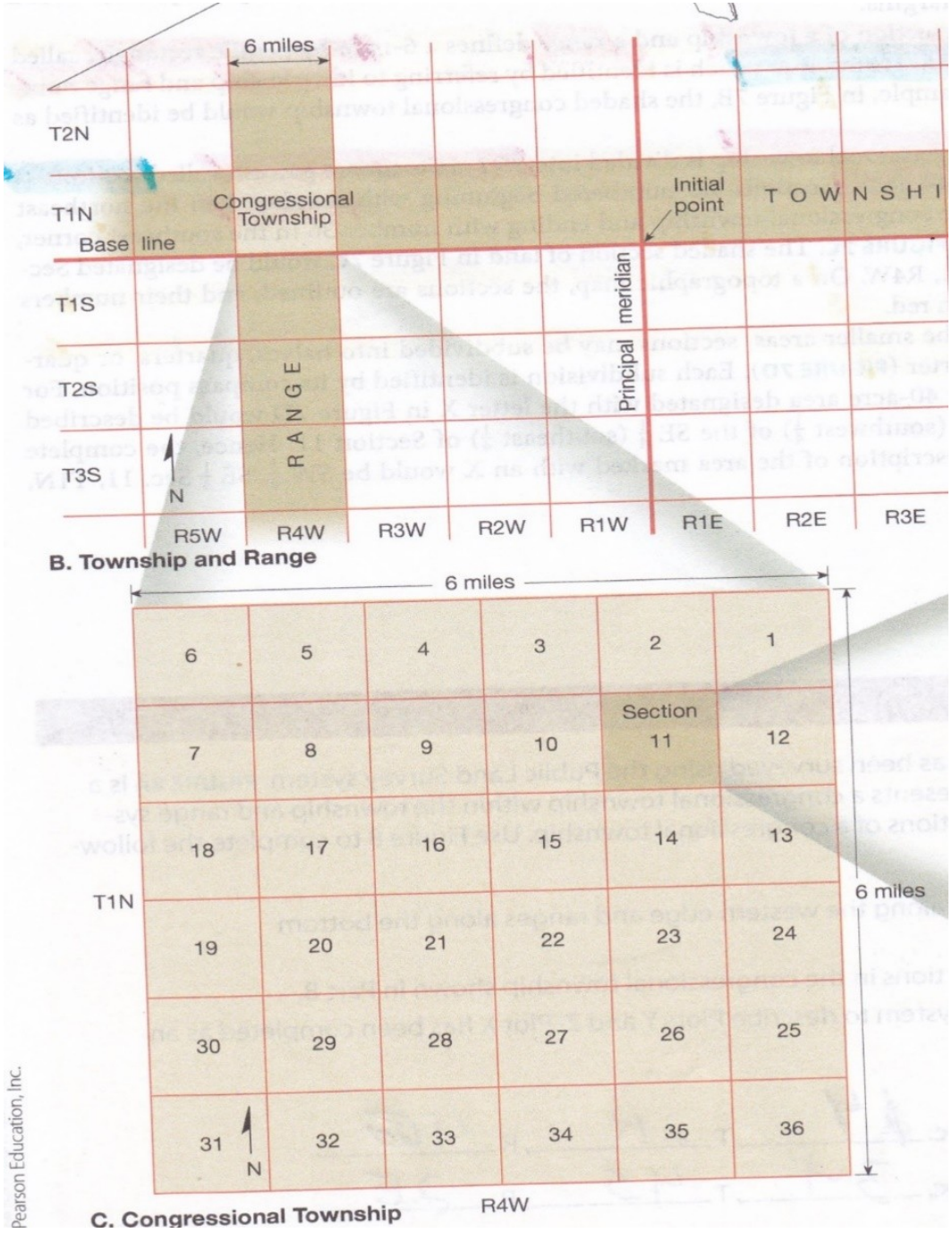
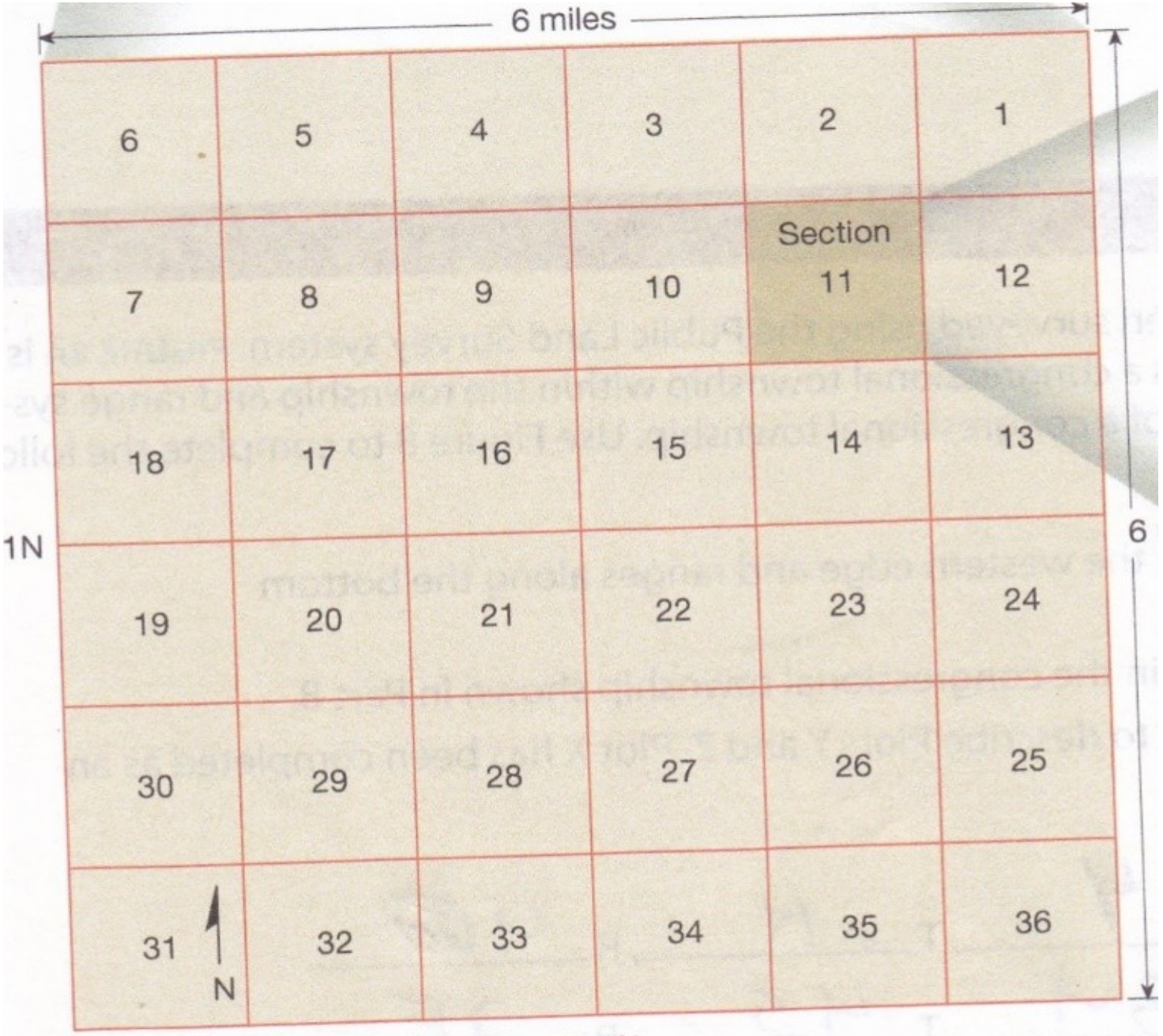
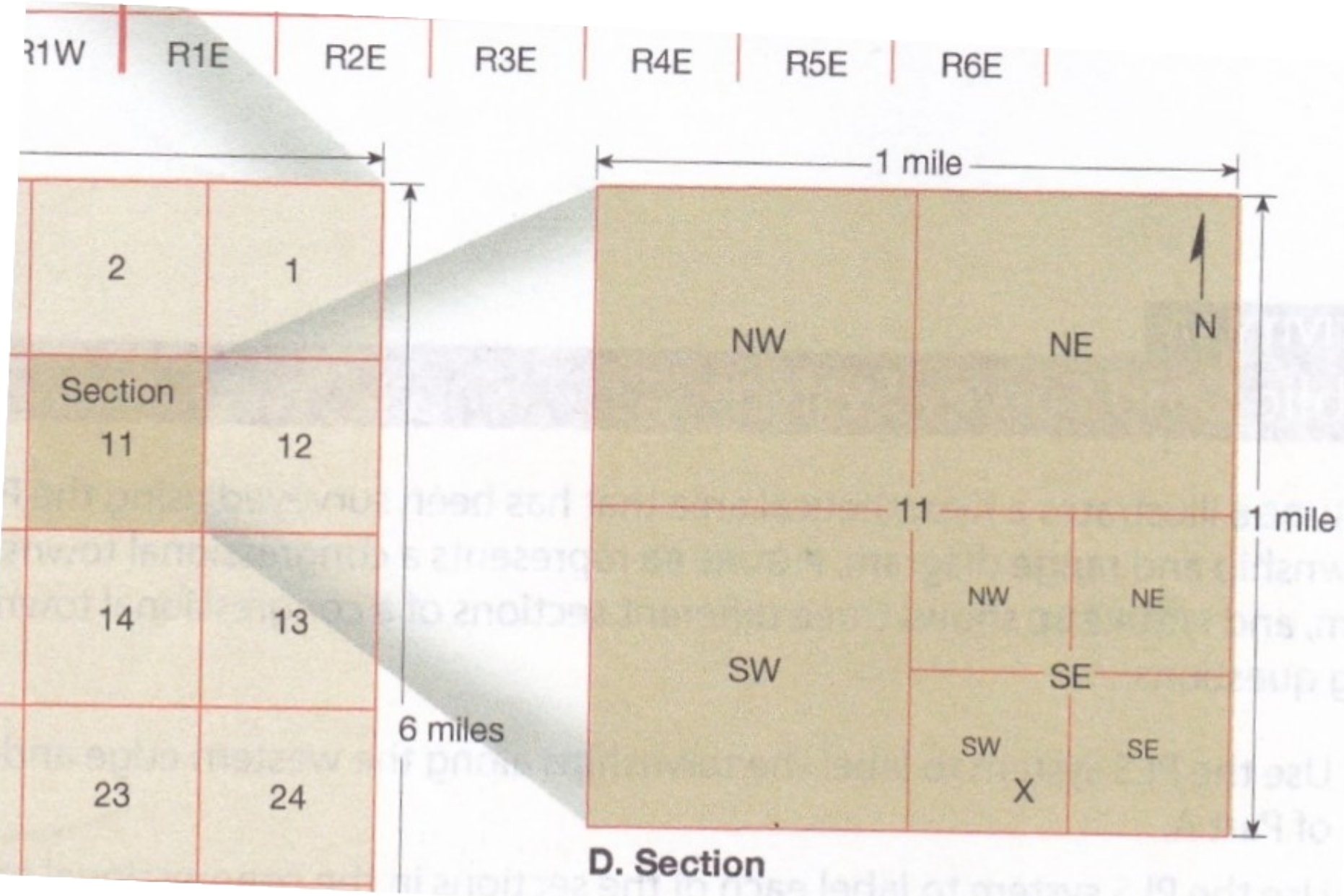



Pearson Education, Inc.



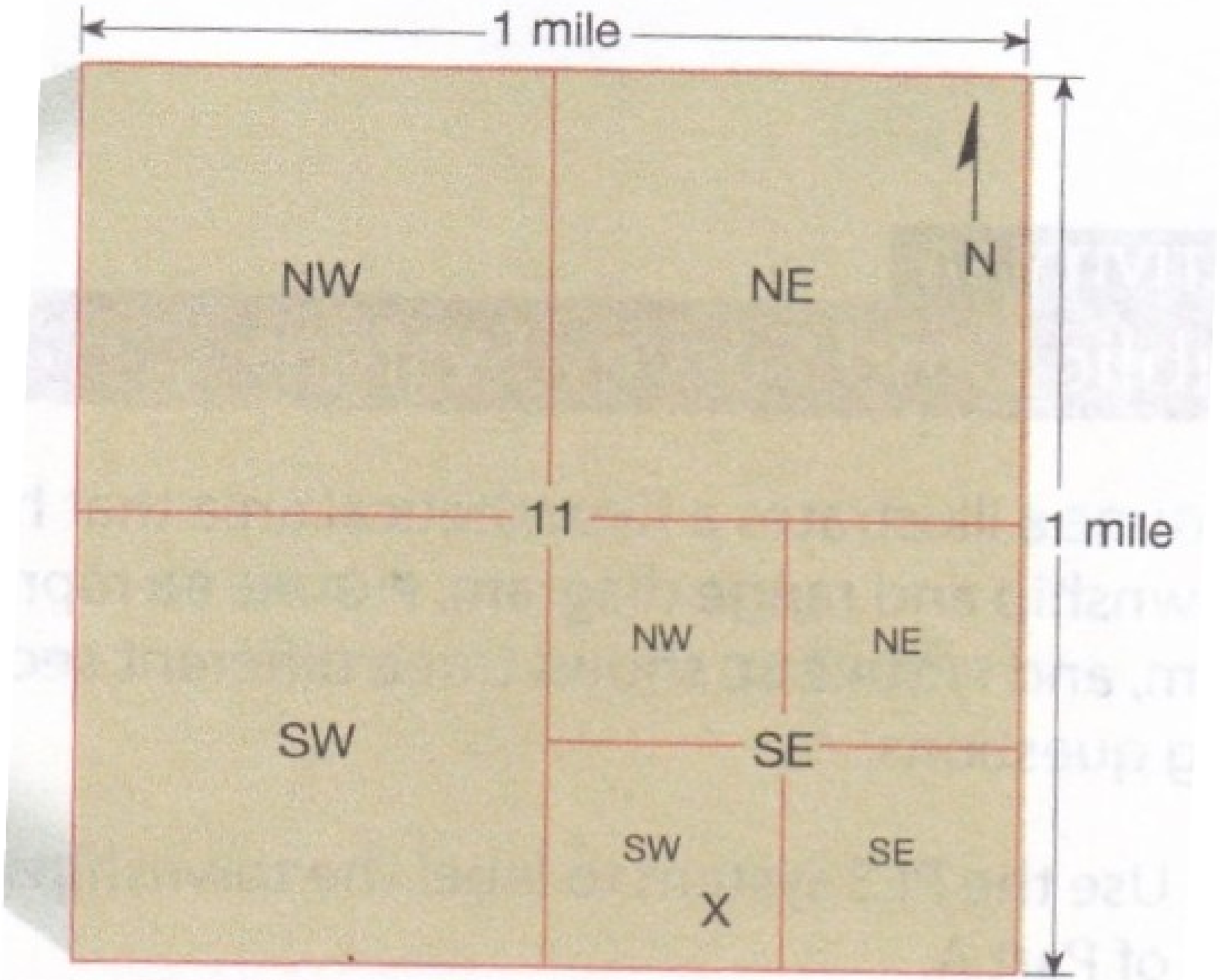

. Congressional Township

© McGraw Hill




D. Section

© McGraw Hill




**D. Section**

© McG

# Map Projections (1)

**Earth can be represented with reasonable accuracy only on a globe**

In transforming a globe into a map, one cannot keep intact all these globe properties

- All meridians are equal in length
- All **meridians converge at the poles**
- Lines of latitude are parallel to the equator and to each other
- Parallels decrease in length as one nears the poles
- Meridians and parallels intersect at right angles
- The scale on the surface of the globe is the same everywhere in all directions

© McGraw Hill

# Map Projections (2)

## Map projection

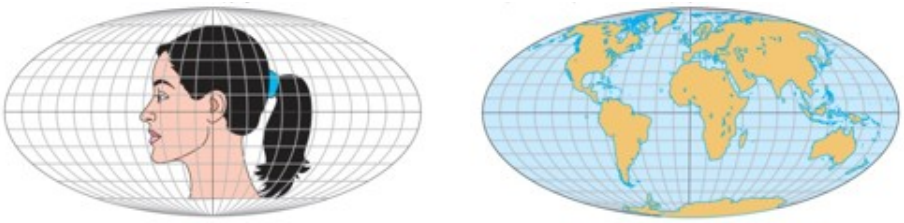
- Method of representing the curved surface of the globe on a flat map

***All flat maps distort some or all of the four main properties of actual earth surface relationships***:

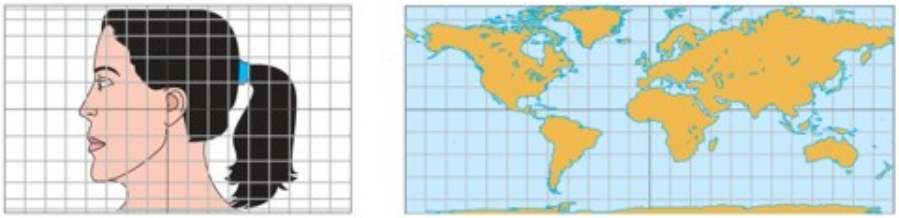
- Area
- Shape
- Distance
- Direction

© McGraw Hill

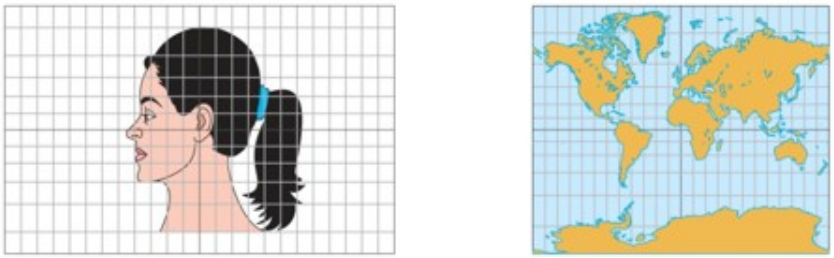
# Distortion



a)



b) A cylindrical equal-area projection with standard parallels at 30°N and S

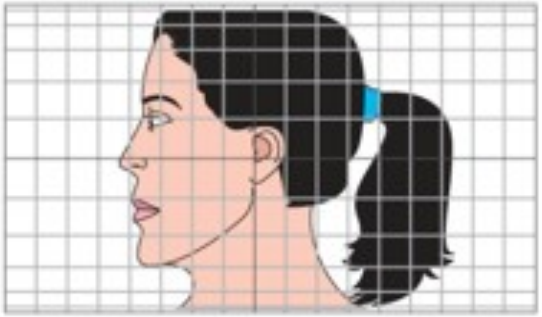


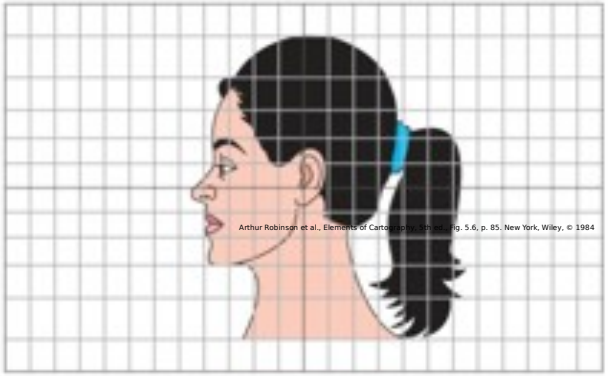
c) Mercator projection

© McGraw Hill

Arthur Robinson et al., Elements of Cartography, 5th ed., Fig. 5.6, p. 85. New York, Wiley, © 1984

# Distortic



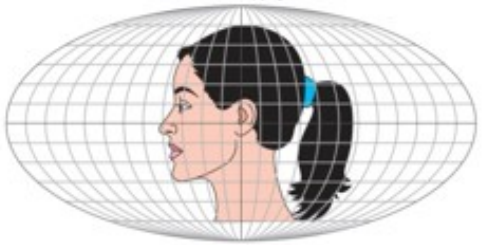


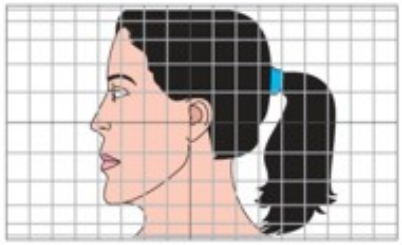
Arthur Robinson et al., Elements of Cartography, 5th ed., Fig. 5.6, p. 85. New York, Wiley, © 1984

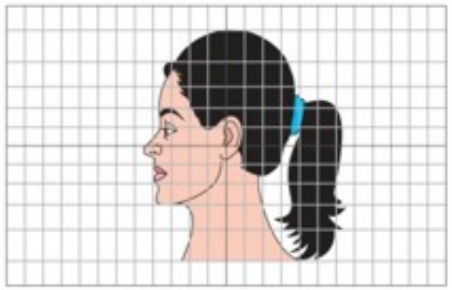
© McGraw Hill

# Distortion

This figure illustrates the distortion inherent in three different map projections. A head drawn on one projection (Mollweide) has been transferred to two other projections, keeping the latitude and longitude the same as they are found on the first. This **does not mean the first projection is the best of the three**. The head could have been drawn on any one of them and then plotted on the others.







© McGraw Hill

# Map Projections (3)

## Equidistant projections

- Distances are true in all directions from one or two central points
  - Distances between all other locations are incorrect

**A map cannot be both Equidistant and Equal-Area.**

© McGraw Hill

# Equidistant Projection

a)Azimuthal equidistant projection, polar case

©McGraw Hill

# Equidistant Projection

a)On this equidistant projection, distances and directions to all places are true only from the center (North Pole). **No flat map can be both equidistant and equal-**

© McGraw-Hill

# Map Projections (4)

**Azimuthal projections**

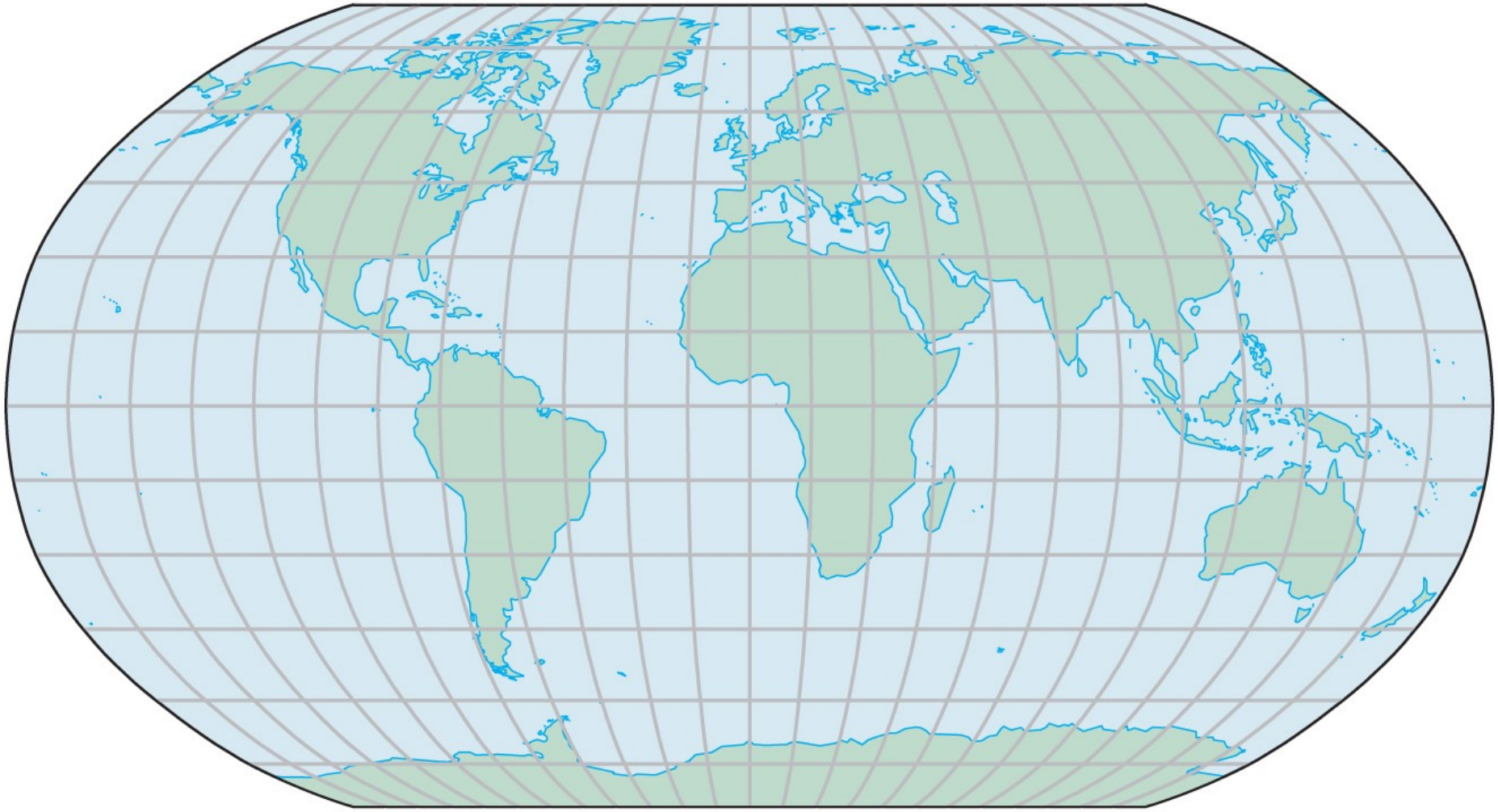
- **Directions are true from one central poin all others**
  - Directions from other points are not accurate
- May also be equivalent, conformal or equidista

**Robinson projection**

- **Compromise** between equal-area and conformal
- Does not show true distances or directions

© McGraw Hill

# Robinson Projection

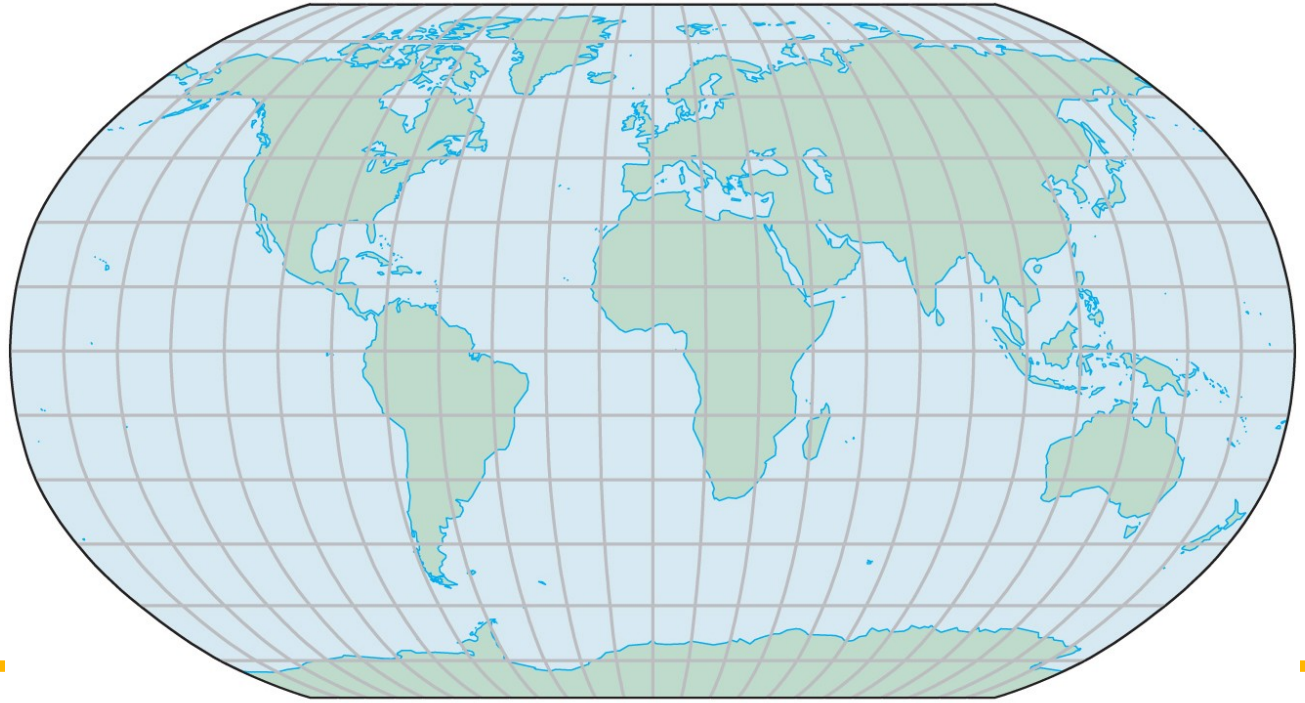


b)Robinson projection

© McGraw Hill

# Robinson Projection

b) The **Robinson projection**, a compromise between an equal-area and a conformal projection, gives a **fairly realistic view of** the world. The most pronounced shape distortions are in the less-populated areas of the higher latitudes, such as northern Canada, Greenland, and Russia. On the map, Canada is 21% larger than in reality, while the 48 contiguous states of the United States are 3% smaller than they really are.



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# 3. The Geographic Grid

## Small Circles and Great Circles

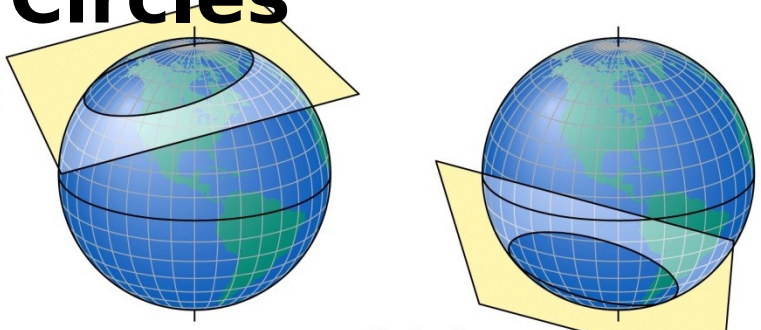


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Figure 1.5 part 2

### Small Circles:

Created when a plane passes through the Earth but does not intersect the center point

### Great Circles:

Created when a plane passes through the Earth, intersecting the center point

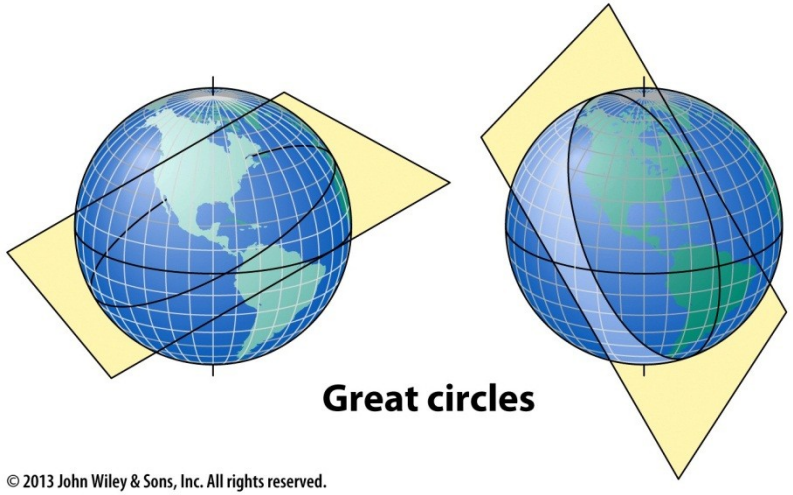


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Figure 1.5 part 1



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# 4. Map Projections

## Mercator Projection

**Mercator** projection shows a line of constant compass bearing as a straight line

- Used to display *directional* features such as wind direction

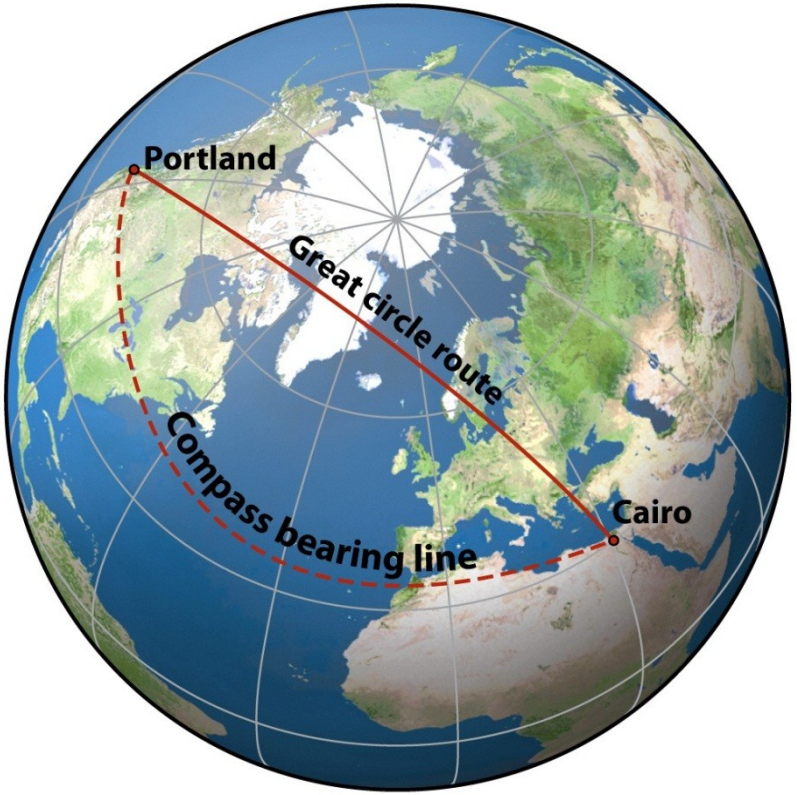


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Figure 1.11 part 2



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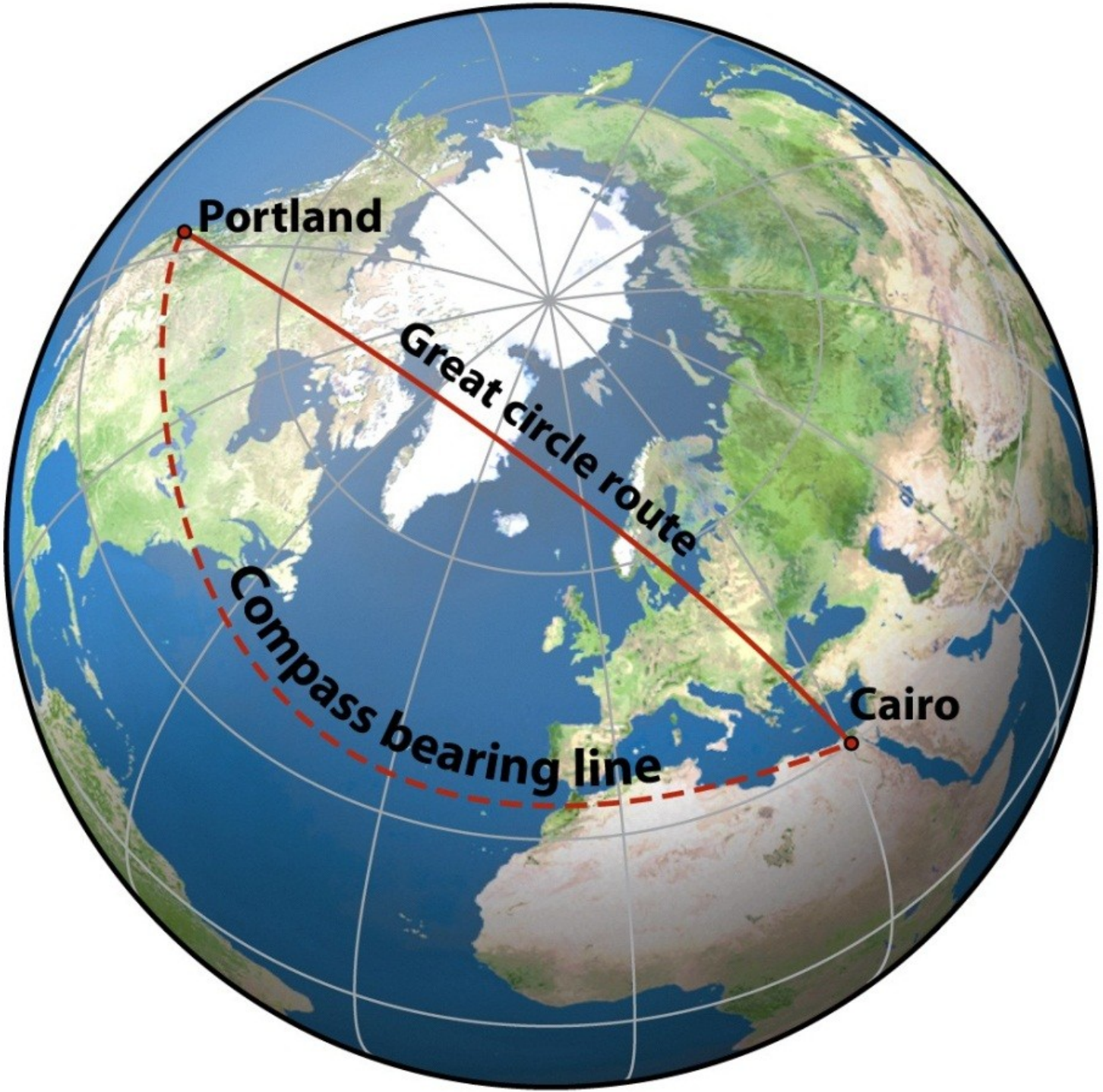


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# 4. Map Projections

## Mercator Projection

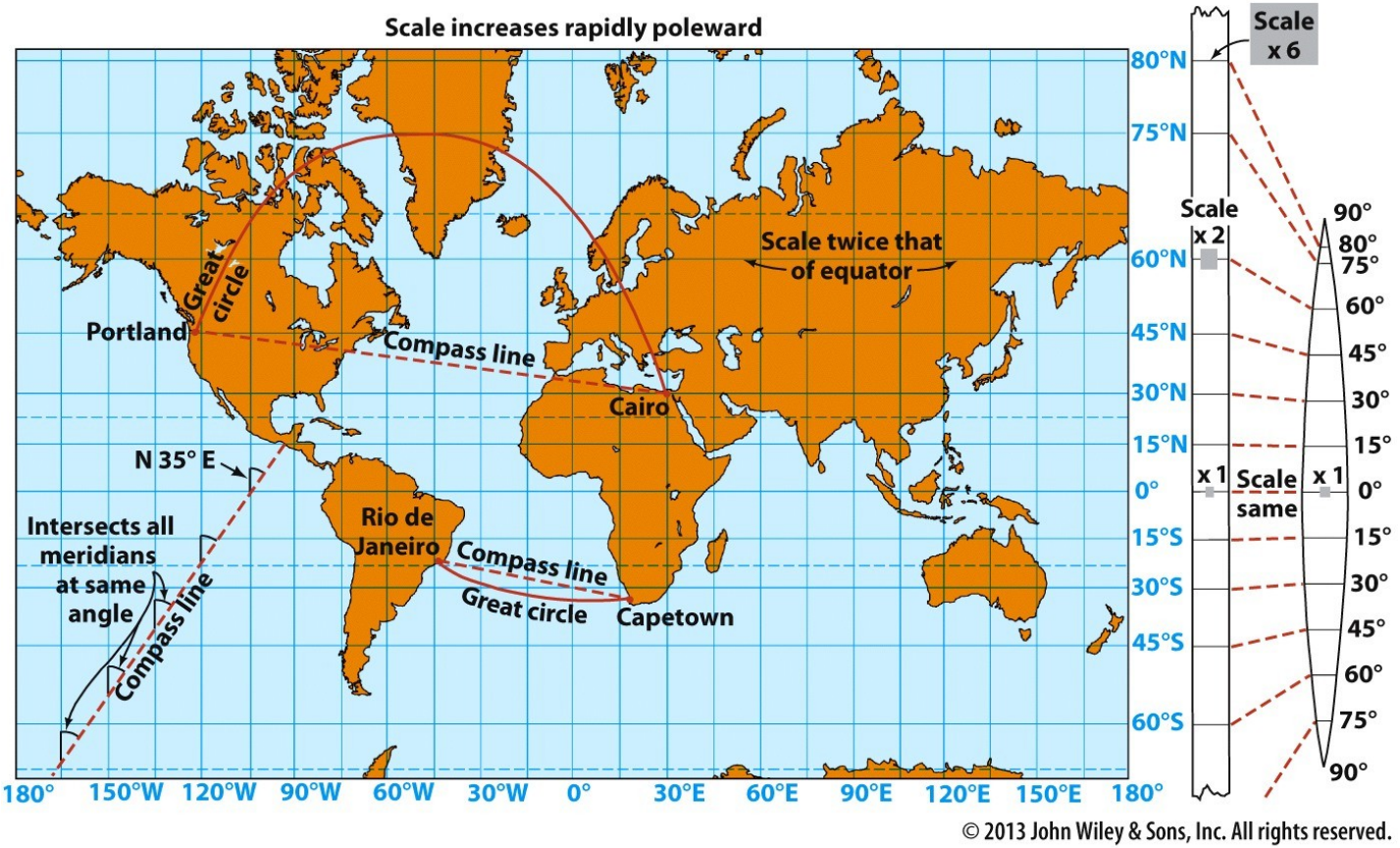


Figure 1.11 part 1



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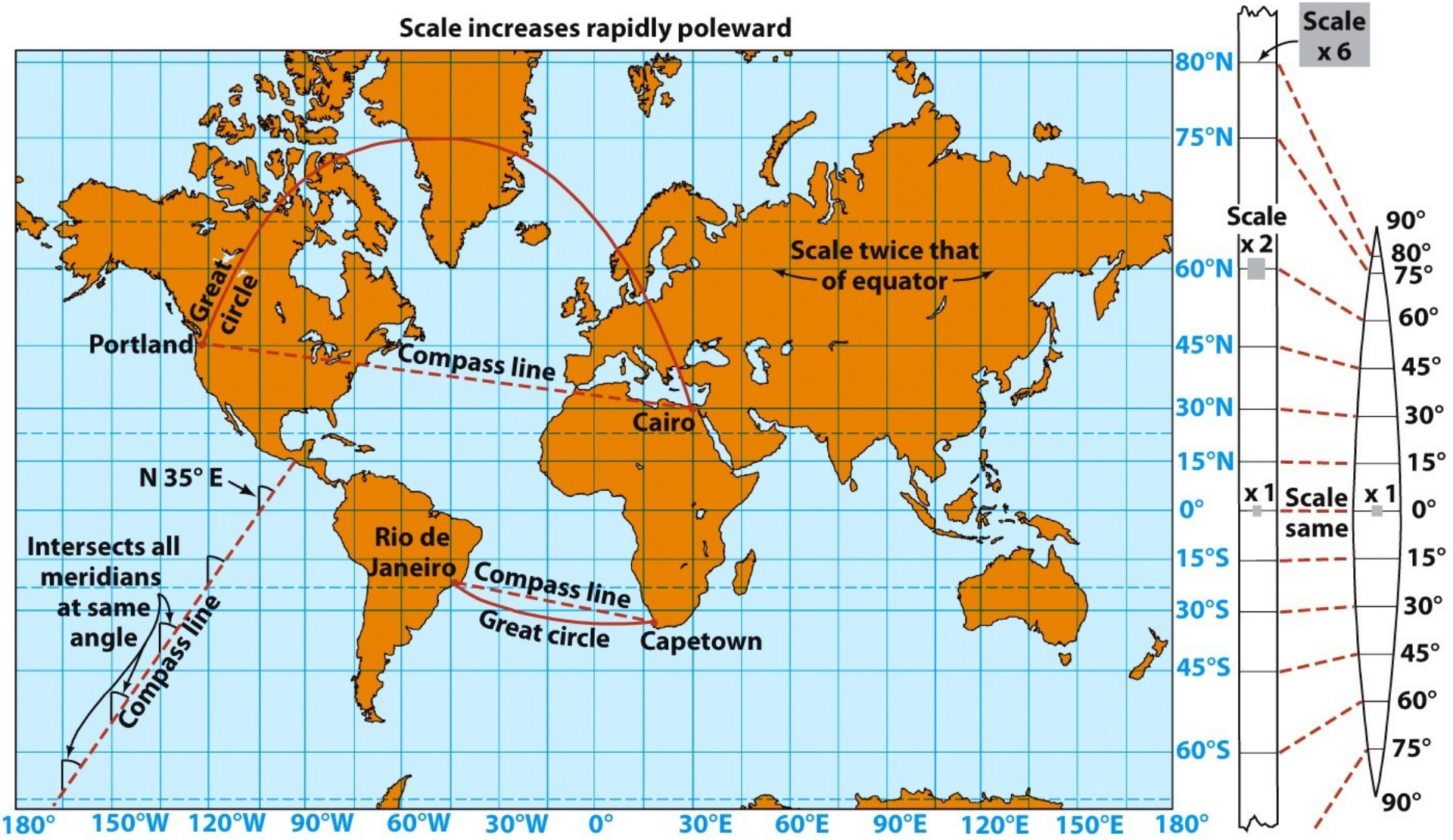


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Figure 1.11 part 1

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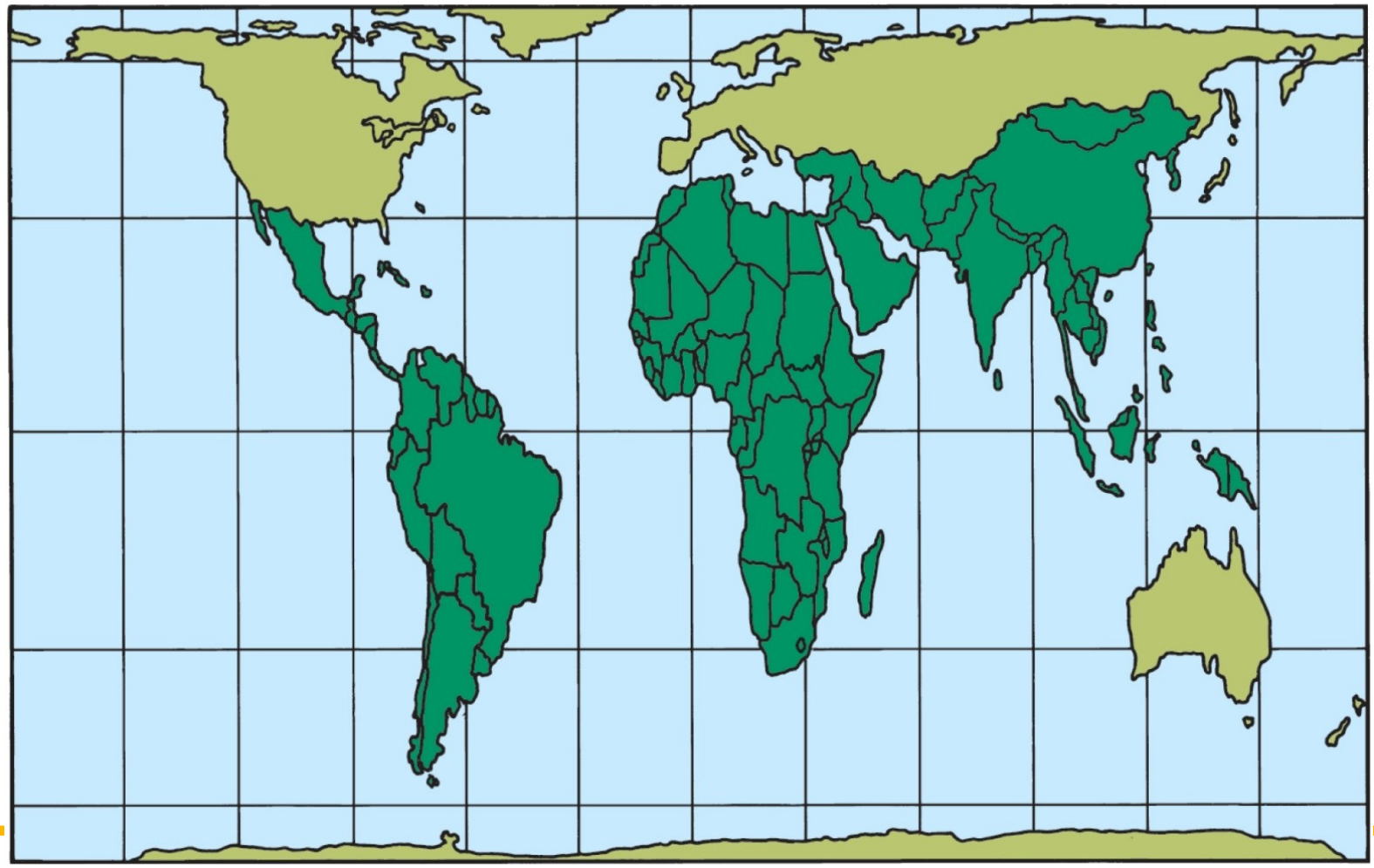
# The Peters Projection

The **Peters projection badly distorts shapes in the tropics and at high latitudes.** Many equal-area projections yield a world map with less distortion.



© McGraw

# Scale

**Ratio** between the measurement of something on a **map** and the corresponding measurement on the **earth**

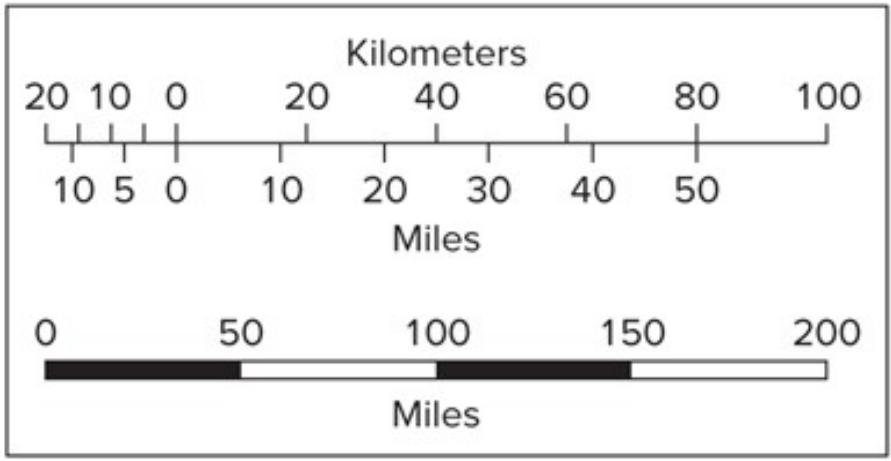
Represented in three ways:

- **Verbal scale**
- **Graphic scale**
- **Representative fraction (RF)**

## a)Verbal scale

"1 inch to 1 mile"
"1 centimeter to 5 kilometers"

## b)Graphic scale




## c)Representative fraction scale

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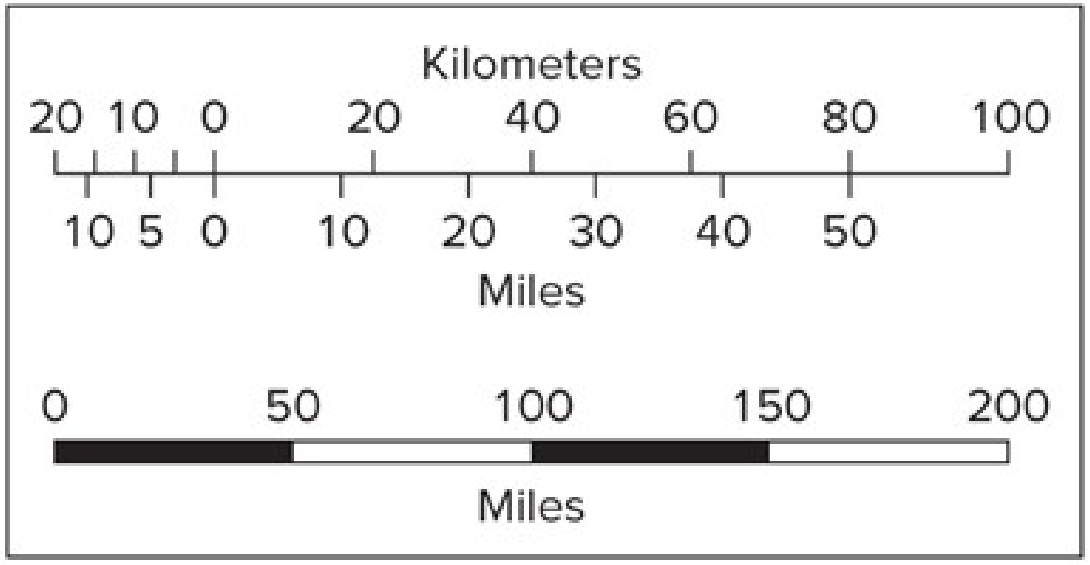
# Scale Long Description

Map scales relate a map distance to a distance on the earth's surface.

a) A **Verbal Scale** is given in words.

b) A **Graphic Scale** divides a line into units, each unit representing the distance between two points on the earth's surface. The graphic scale is the only kind of scale to remain correct if the map is reproduced as a different size, provided tha the scale is enlarged or reduced by the same percentage.

c) A **Representative Fraction (RF)** scale is a simple fraction or ratio. The units o distance on both sides of the scale must be the same; they need not be stated.




- "1 inch to 1 mile"
- "1 centimeter to 5
- kilometers"

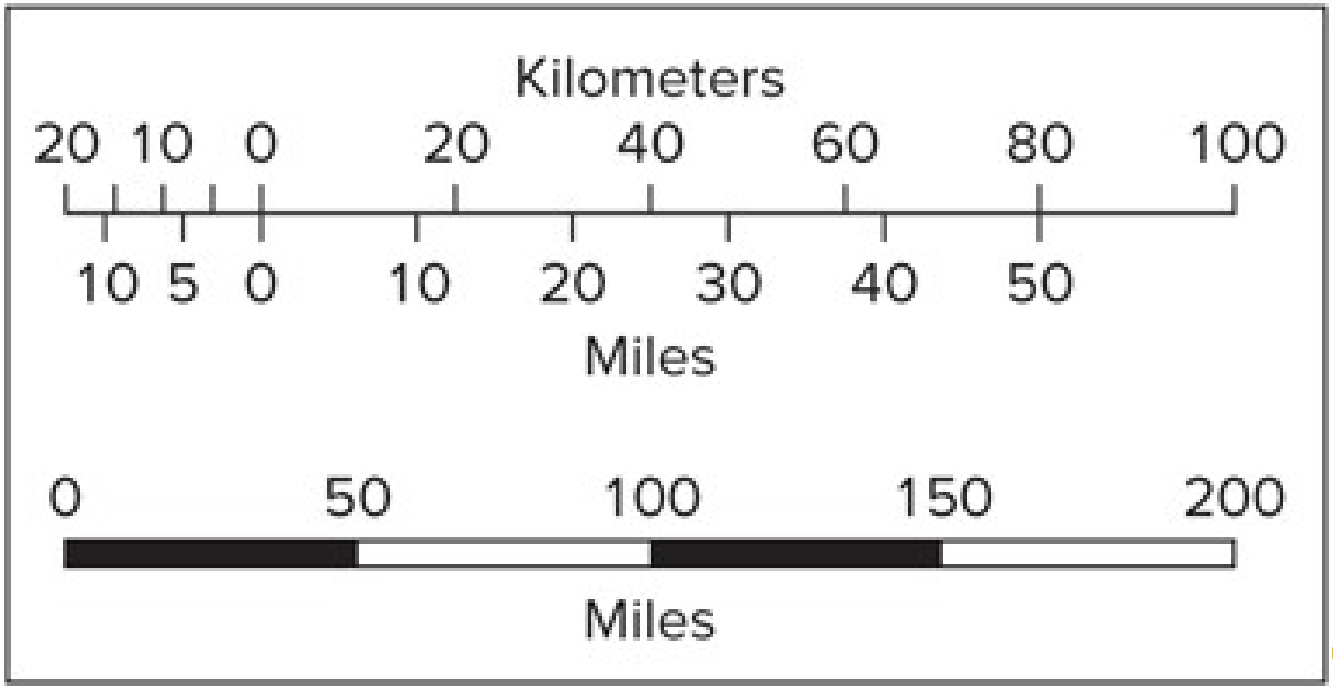
© McGraw Hill

# A **Verbal Scale** is given in words

"1 inch to 1 mile"
"1 centimeter to 5 kilometers"

© McGraw Hill

A **Graphic Scale** divides a line into units, each unit representing the distance between two points on the earth's surface. The graphic scale is the **only kind of scale to remain correct if the map is reproduced as a different size**, provided that the scale is enlarged or reduce



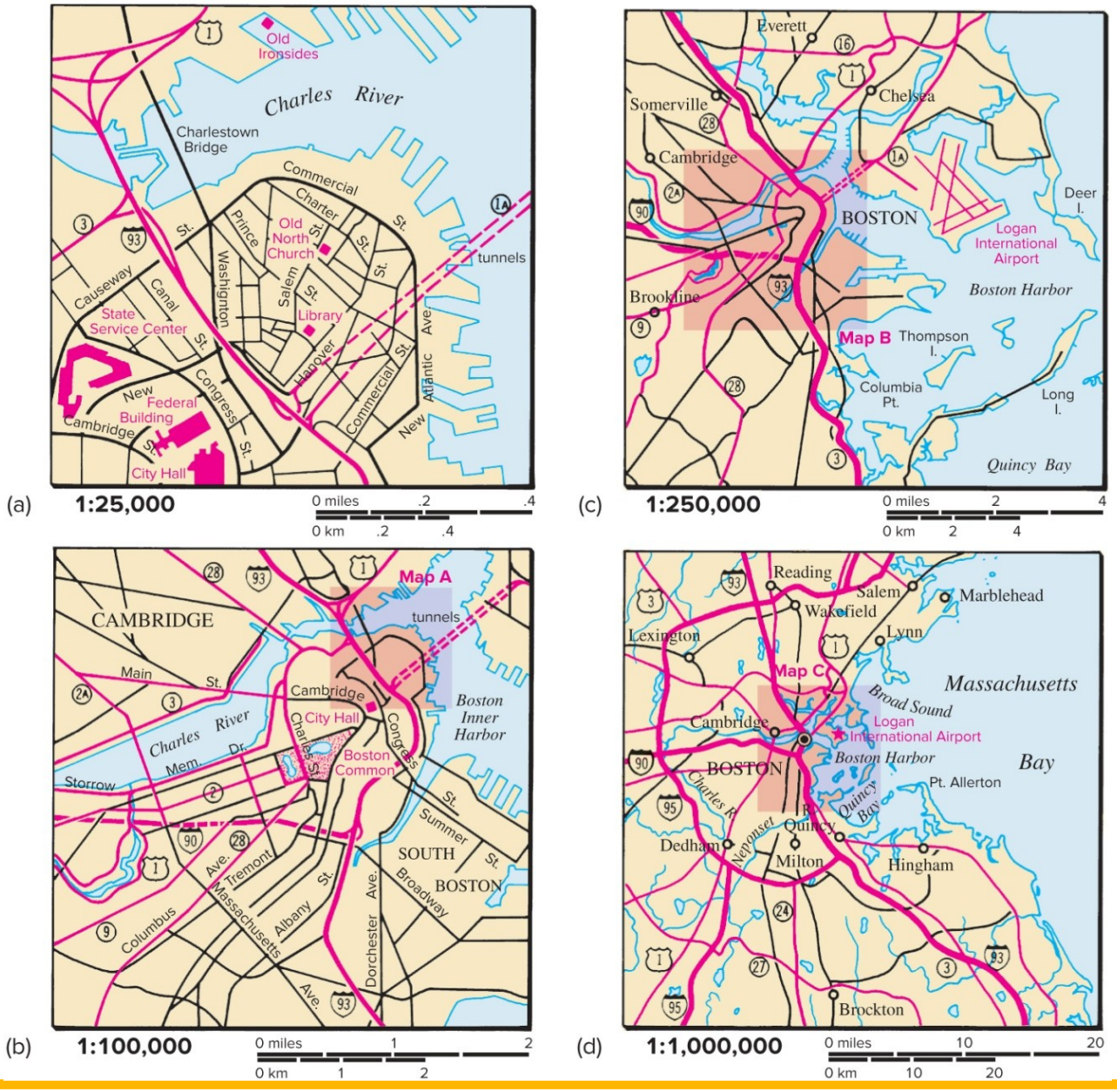

© McGraw Hill

a)A **Representative Fraction (RF)** scale is a simple fraction or ratio. The units of distance on both sides of the scale must be the same; they need not be stated.

- 

© McGraw Hill

# Effect of Scale



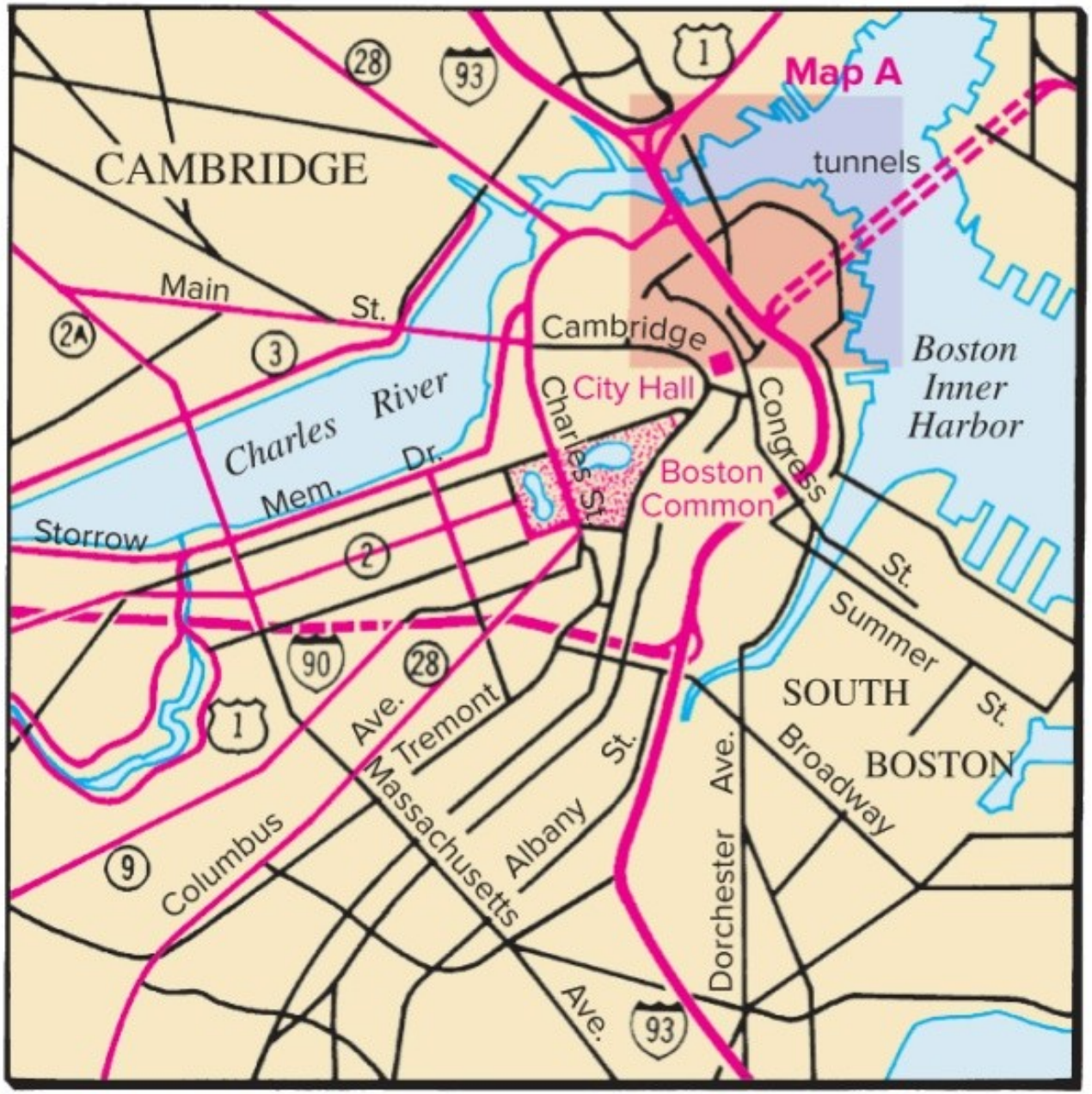

© McGraw Hill

The **effect of scale** on area and detail. The four maps all show Boston, but at **different scales**. The larger the scale, the greater the number and kinds of features that can be included. Among other things, at a scale of 1:25,000, map (a) shows streets, street names, and some buildings. Map (d), at the **smallest scale**, shows only **major cities, highways, and water bodies**. The area shown in map (a) is indicated by the pink square on map (b), the area covered in (b) by the pink square on map (c), and the area of map (c) by the square on map (d).

©McGraw Hill

**Large Scale** of 1:25,000, map (a) shows streets, street names, and some buildings. Map

© McGraw Hill



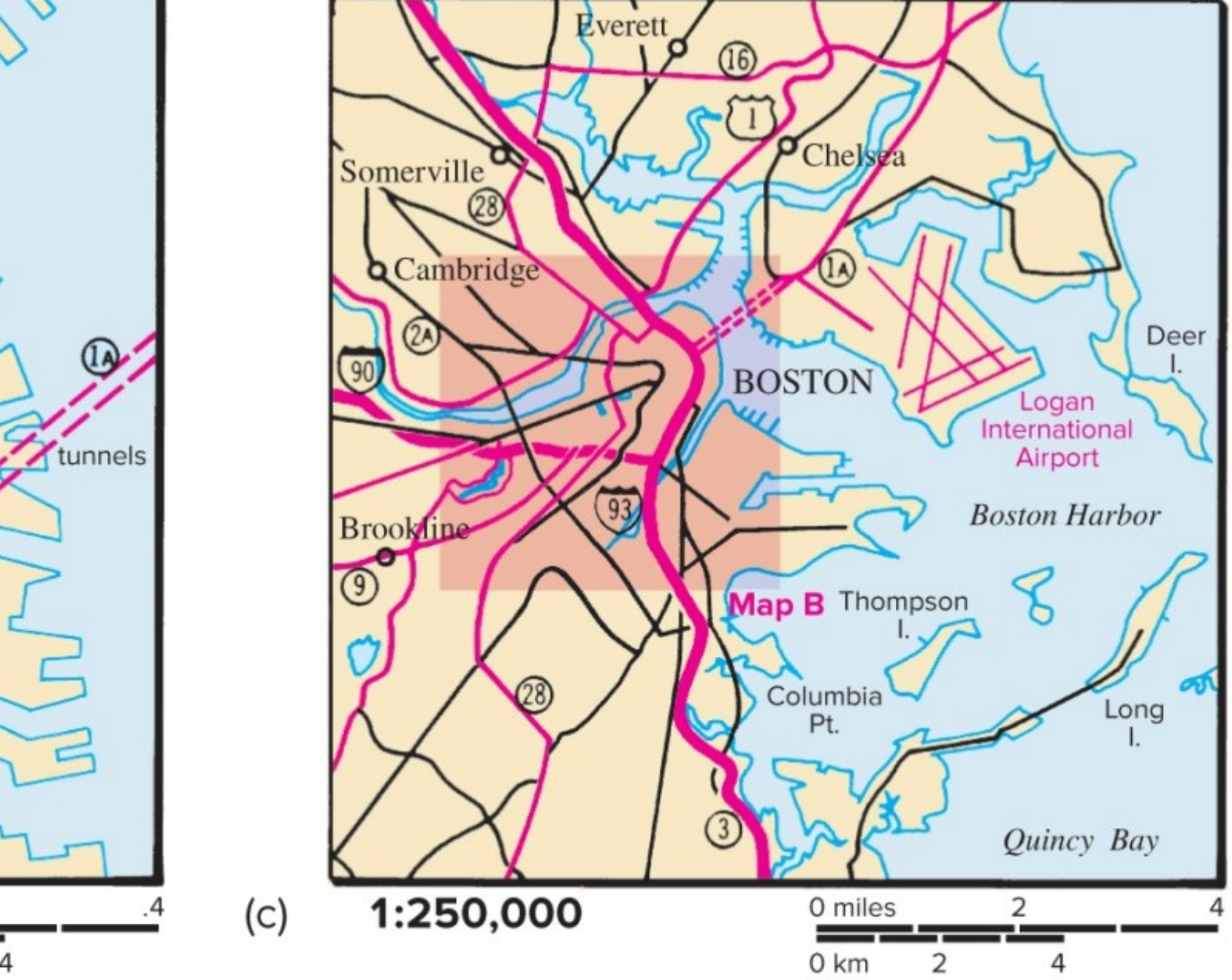

(b) **1:100,000**

0 miles 1 2

0 km 1 2

(d)

© McGraw Hi


Everett
16
1
Chelsea
Somerville
28
Cambridge
1A
2A
90
BOSTON
Deer
I.
Logan
International
Airport
93
Boston Harbor
Brookline
9
Map B
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28
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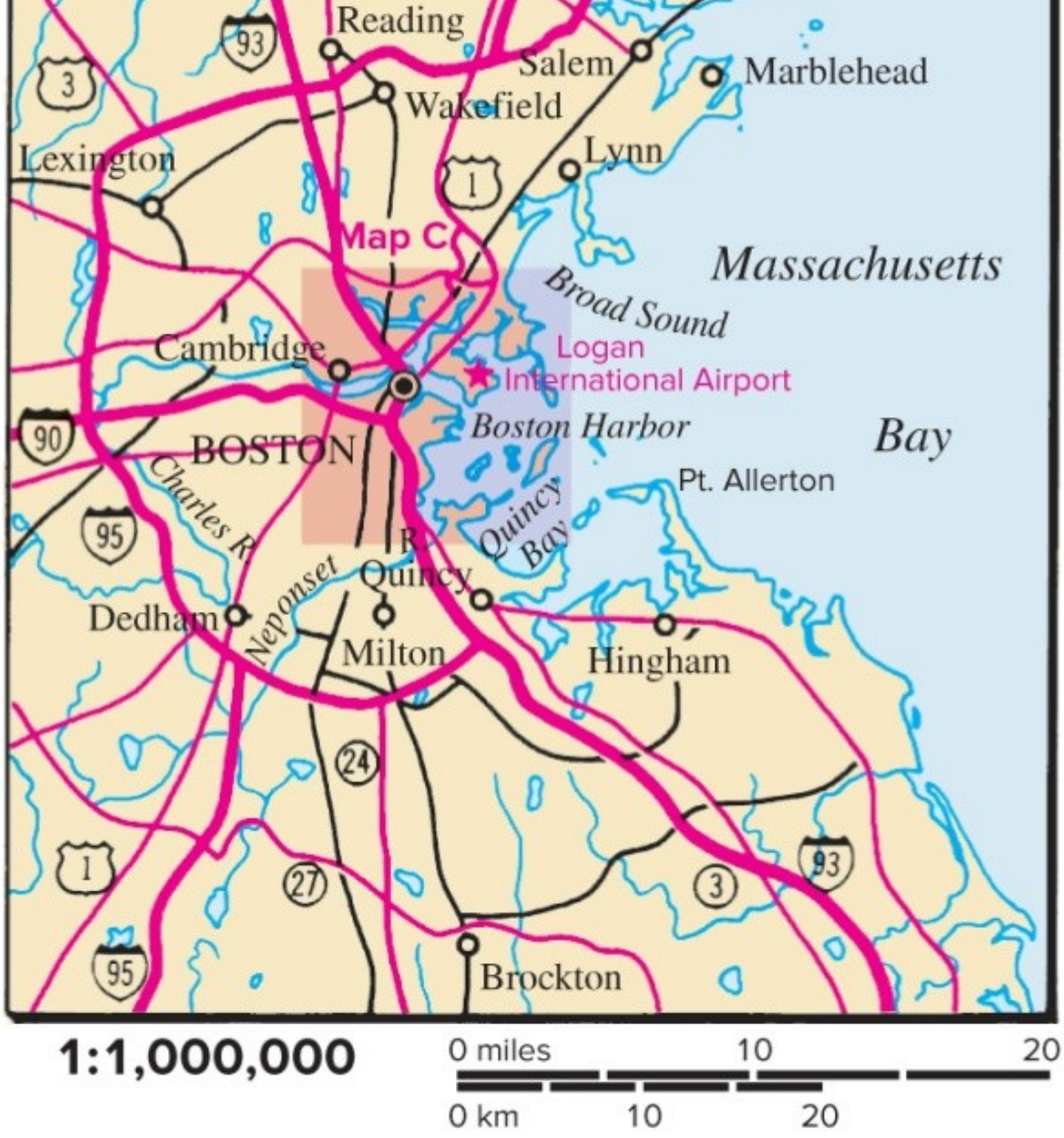


**Smallest Scale**

shows only major cities, highways, and water bodies.

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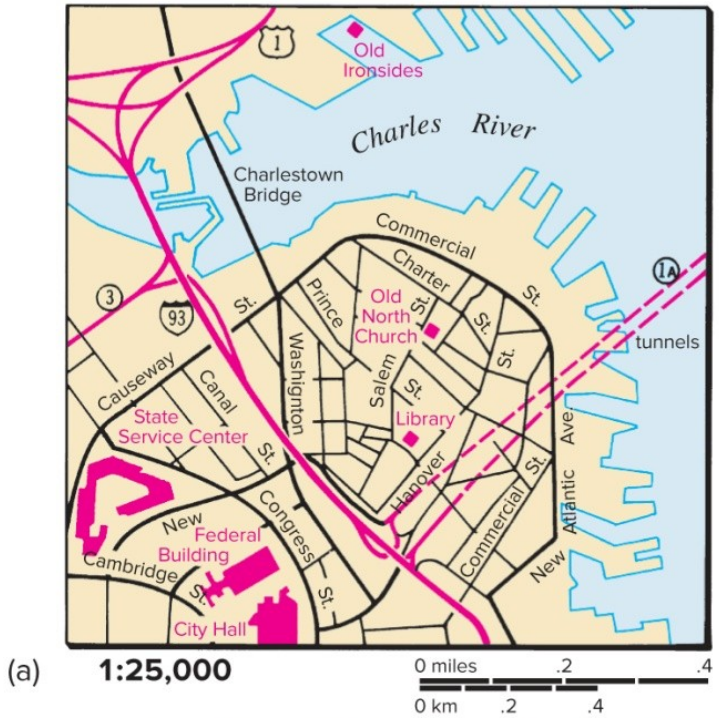
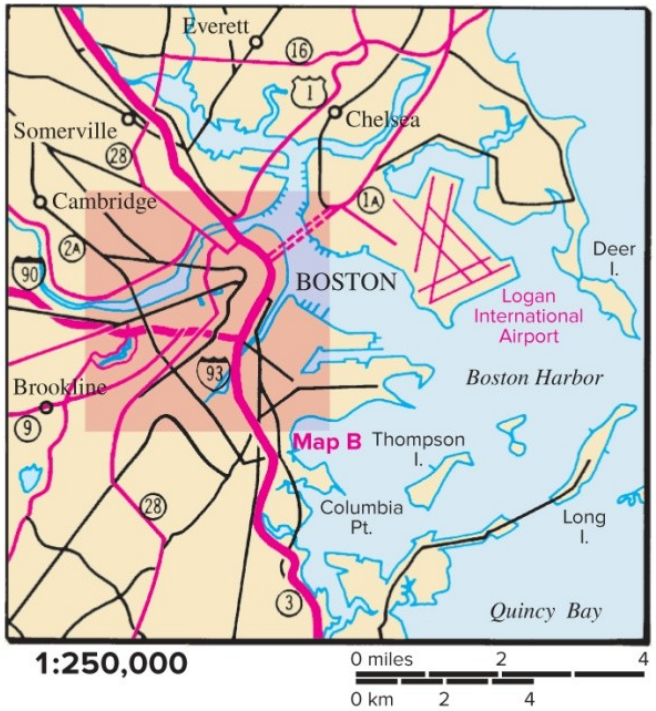
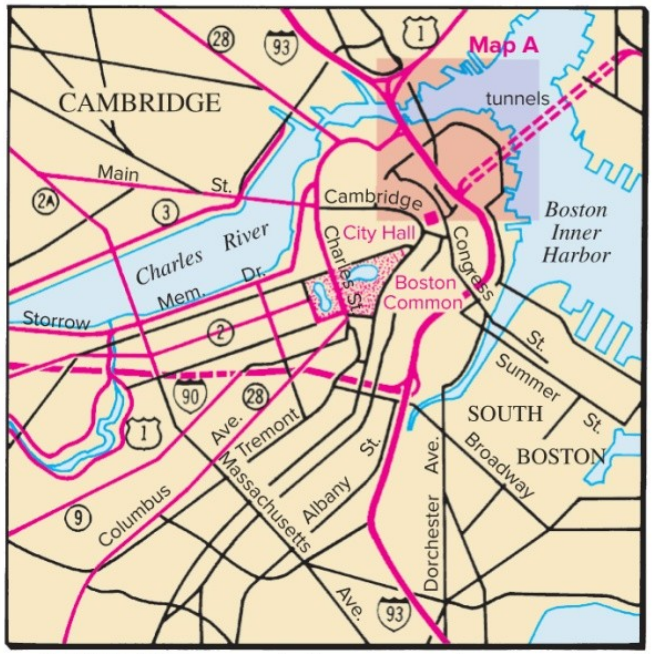



(a)




(c)




(b)

(d)

© McGraw I

# Types of Maps

**Geographers choose map features** that are **relevant to the problem** at hand and then decide **how to display** them in order to **communicate their message.**

## General-purpose (reference or location) maps.

- Display one or more natural and/or cultural features of an area or of the world as a whole.

## Thematic (special purpose) maps.

- Show a **specific** spatial **distribution** or **category of data**.
  - Natural and/or cultural phenomena.

© McGraw Hill

# Types of Maps: Topographic Maps and Terrain Representation (1)

**Topographic maps** are general-purpose maps

- Depict the **shape** and **elevation** of terrain
- Include natural and cultural features

US Geological Survey (USGS) topographic map series for entire US

Available at scales of 1:250,000 and 1:100,000 as well as other scales. Single map in a series is called a **quadrangle**

© McGraw Hill

# 7.5-minute Series of U.S. Geological Survey Topographic map

© McGraw Hill

# Maps and Terrain Representation (2)

Methods of depicting relief (variation in elevation)

## Spot heights

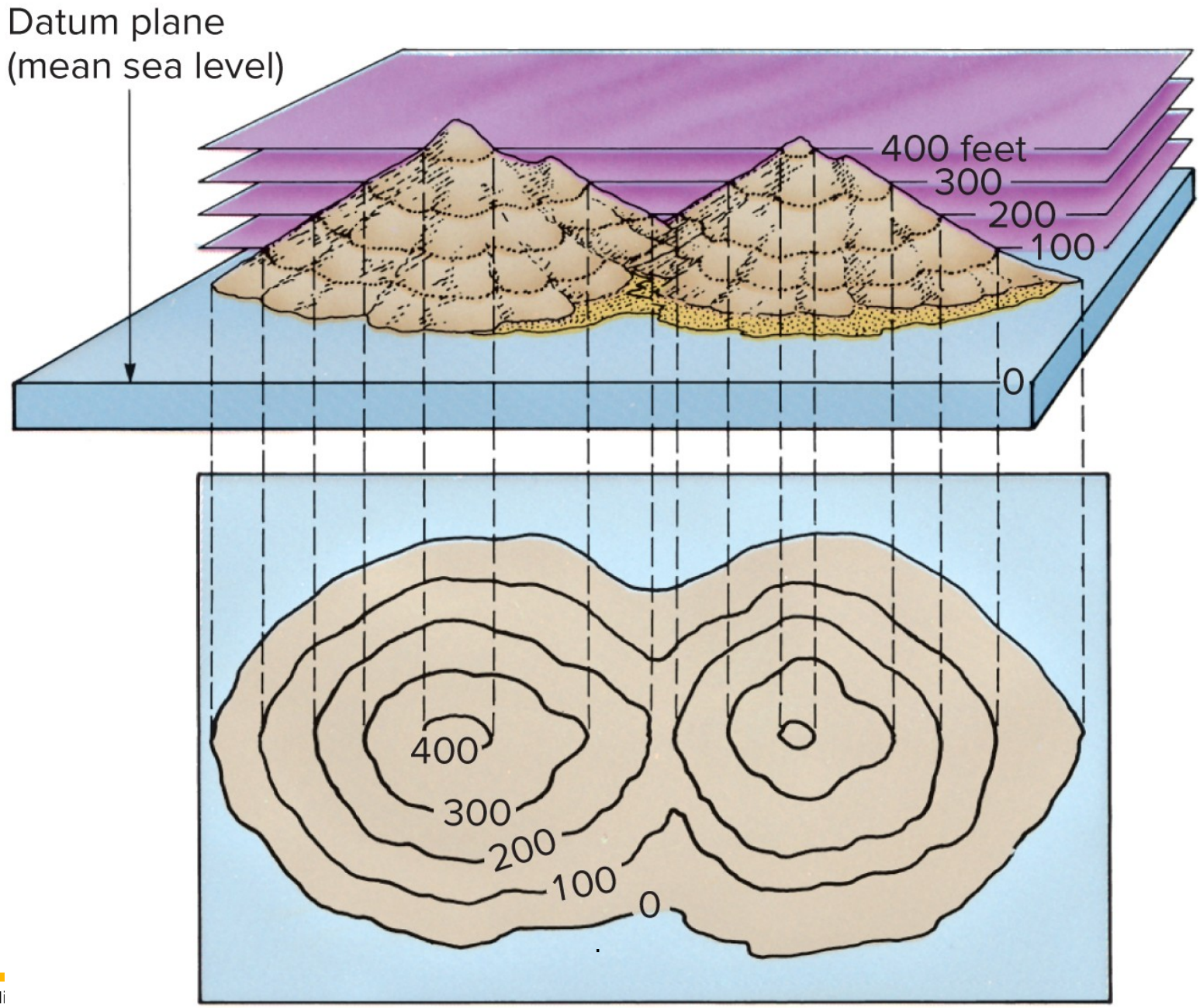
- Numbers indicate elevation of selected points
- **Bench mark**, a particular type of spot height, is used as a reference in calculating elevations of nearby locations

## Contour line

- Symbol to show elevation
- All points along the line are of equal elevation above a datum plane, usually mean sea level
- **Contour Interval** is the vertical spacing between contour lines

© McGraw Hill

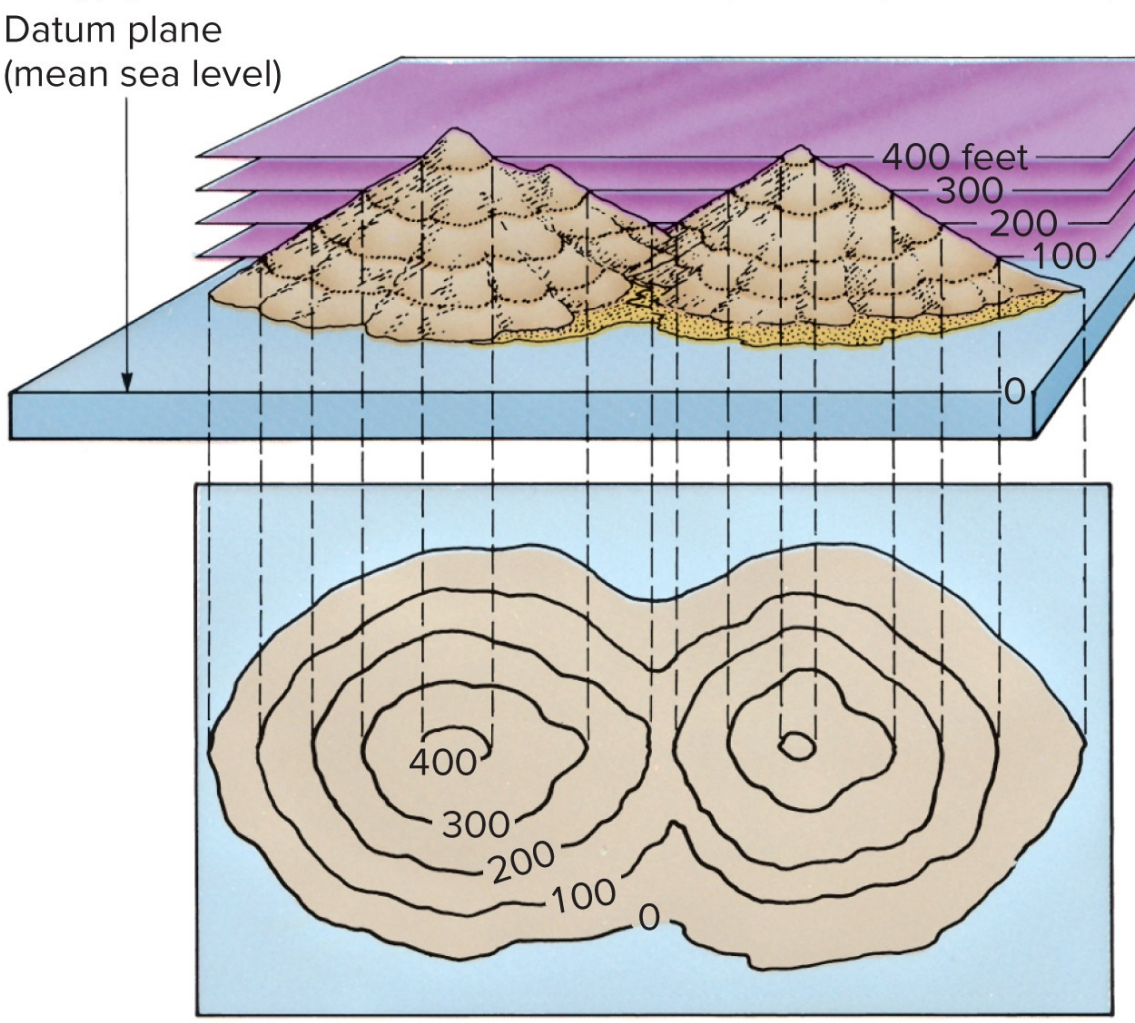
# Contours Drawn for an Imaginary Island




© McGraw Hi

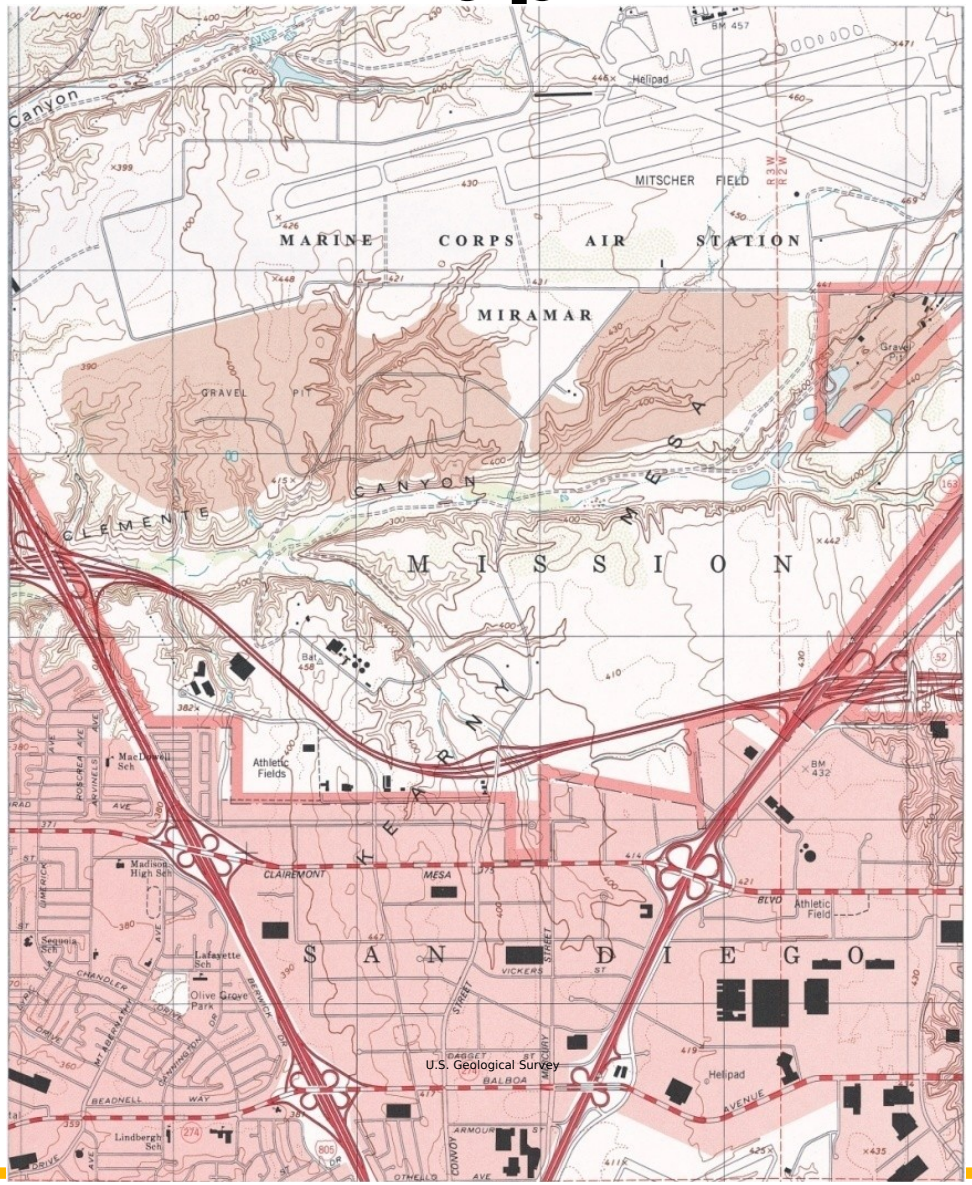
# Contours Drawn for an Imaginary Island

**Contours** drawn for an imaginary island. The intersection of the landform by a plane held parallel to sea level is a **contour** representing the height of the plane above sea level.




© McGraw Hill

# 7.5-minute Series of U.S. Geological Survey Topographic map

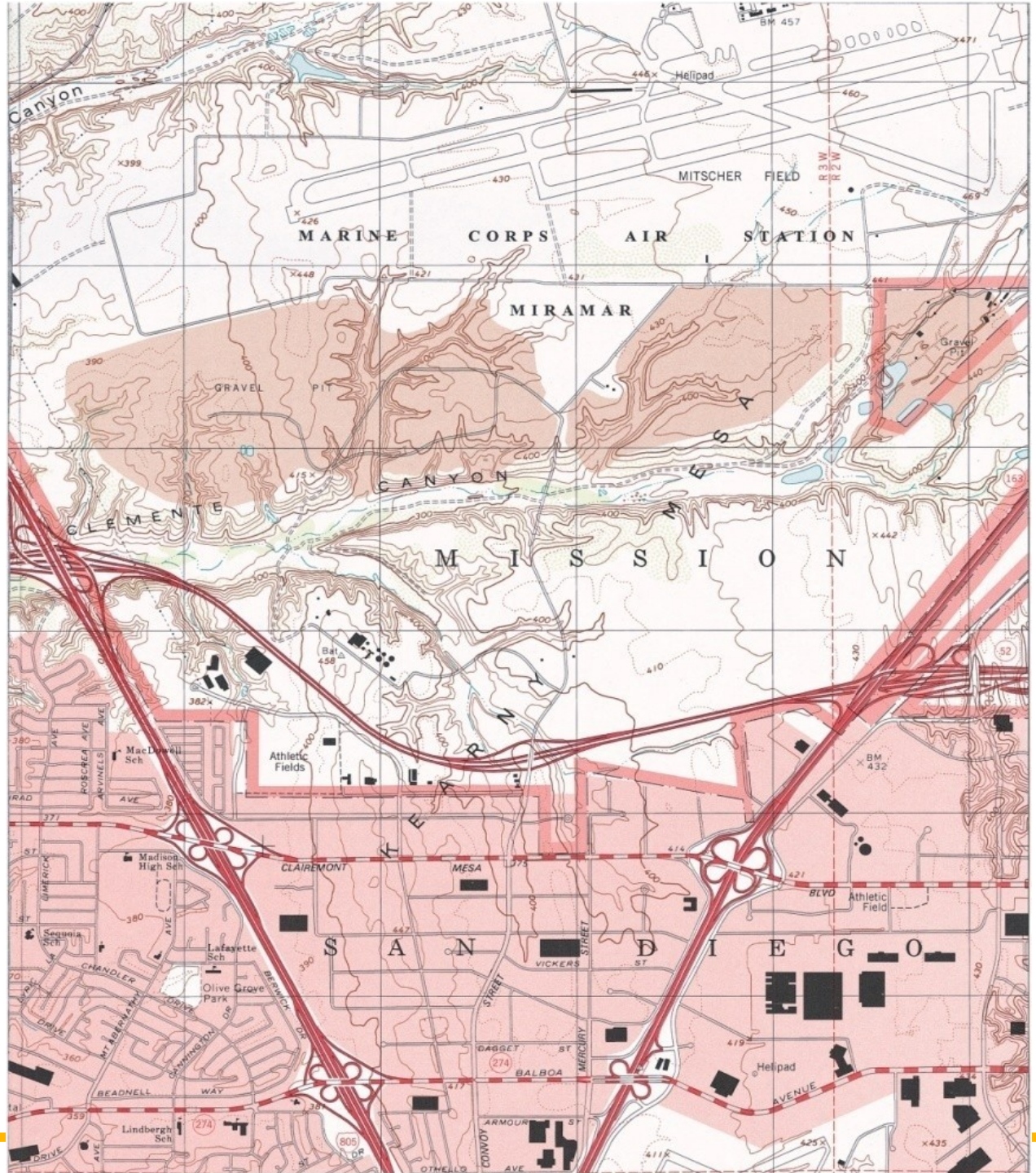



© McGraw Hill

# 7.5-minute Series of U.S. Geologica Survey Topographic map

A portion of the La Jolla (San Diego), California, 7.5-minute series of U.S. Geological Survey topographic maps. The fractional scale is 1:24,000 (1 in. equals about 1/3 mi), allowing considerable detail to be shown. The pink tint denotes built-up areas, in which only schools, churches, cemeteries, parks, and other public facilities are shown.

© McGraw Hill


MARINE CORPS AIR STATION
MITSCHER FIELD
MIRAMAR
GRAVEL PIT
CLEMENTE CANYON
MISSION MESA
MISSION VALLEY
SAN DIEGO
Helipad
Athletic Fields
MacDowell Sch
Madison High Sch
Lafayette Sch
Sequoia Sch
Olive Grove Park
Lindbergh Sch
CLAIREMONT MESA BLVD
Athletic Field
VICKERS ST
DAGGET ST
BALBOA AVENUE
Helipad
MERCURY STREET
CONVOY STREET
ARMOUR ST
OTHELLO AVE
BEADNELL WAY
CHANDLER DRIVE
MT ABERNATHY DRIVE
CANNINGTON DR
BERWICK DR
ROSECRA AVE
AVINELS AVE
GMERICK AVE
BM 457
BM 432

© McGraw Hill

MARINE CORPS AIR STATION
MIRAMAR
GRAVEL PIT
Gravel Pit
CANYON
MESA
CLEMENTE
MISSION
Bat
458
Athletic Fields
MacDowell Sch
ROSCREA AVE
ARVINELS AVE
AVE
Madison High Sch
CLAIREMONT
MESA
BLVD
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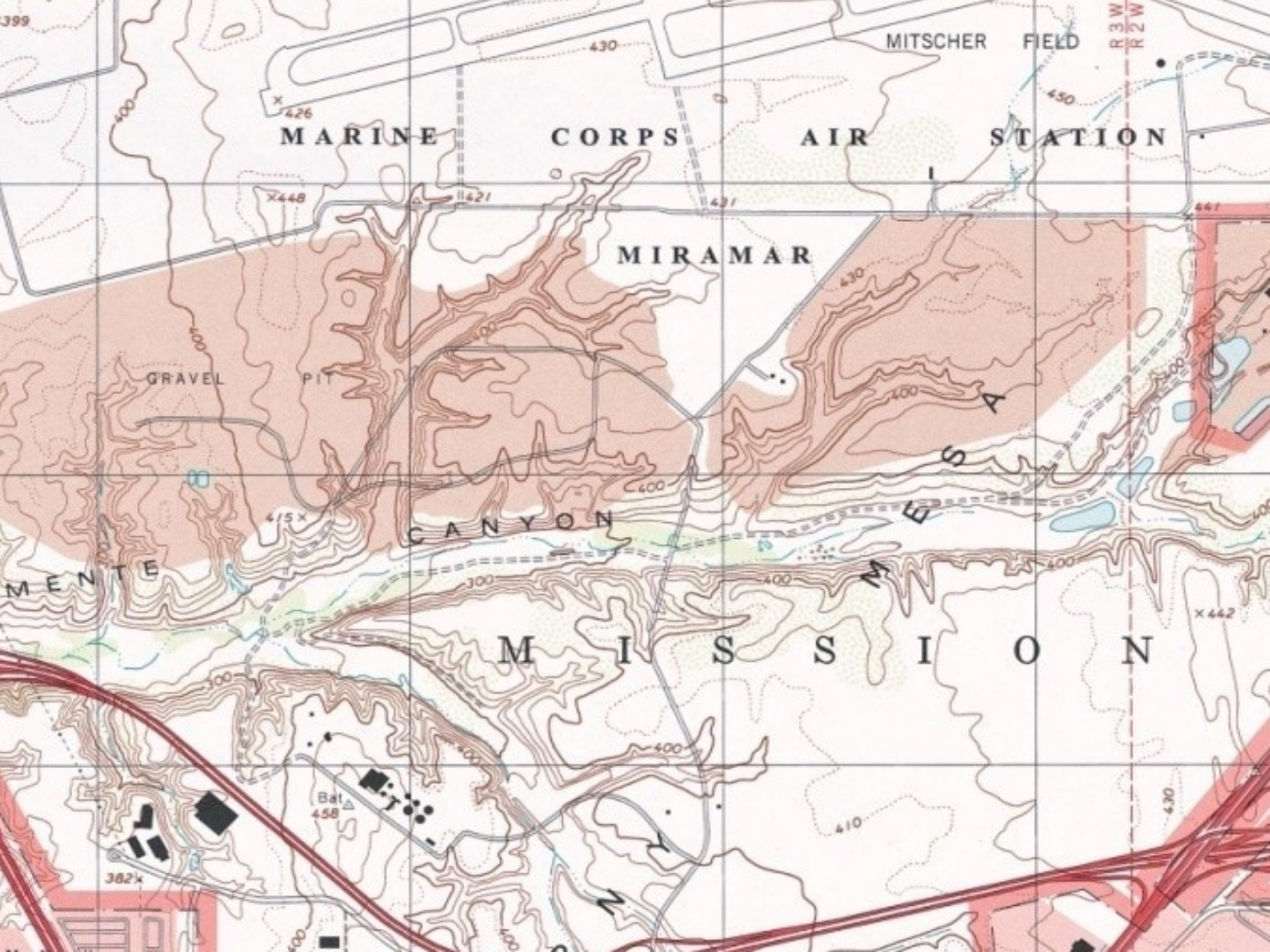
Sequoia Sch
Lafayette Sch
Olive Grove Park
CHANDLER
VICKERS
STREET
ST
163
52


MITSCHER FIELD
MARINE CORPS AIR STATION
MIRAMAR
GRAVEL PIT
CANYON
MESA
MISSION
MENTE
R3W
R2W
430
426
448
421
431
441
400
415
442
410
382
Bat
458

# Types of Maps: Topographic Maps and Terrain Representation (4)

Topographic maps are used by:

- **Engineers**
- Regional planners
- Land use analysts
- **Developers**
- **Hikers**
- And others

© McGraw Hill

# Types of Maps: Topographic Maps and Terrain Representation (3)

Methods of depicting relief (variation in elevation) (continued)

- **Shaded relief**
  - Heightens graphic effect
  - Elevation appears three-dimensional
- **Hypsometric tints**
  - Bands of color for elevation

© McGraw Hill

# Types of Maps: Thematic Maps and Data Representation (1)

## Qualitative map

- Purpose = Show the distribution of a particular class of information; e.g., location of producing oil fields

## Quantitative map

- Purpose = Show the spatial characteristics of numerical data; e.g., population

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# Types of Maps: Thematic Maps and Data Representation (2)

## Point symbols

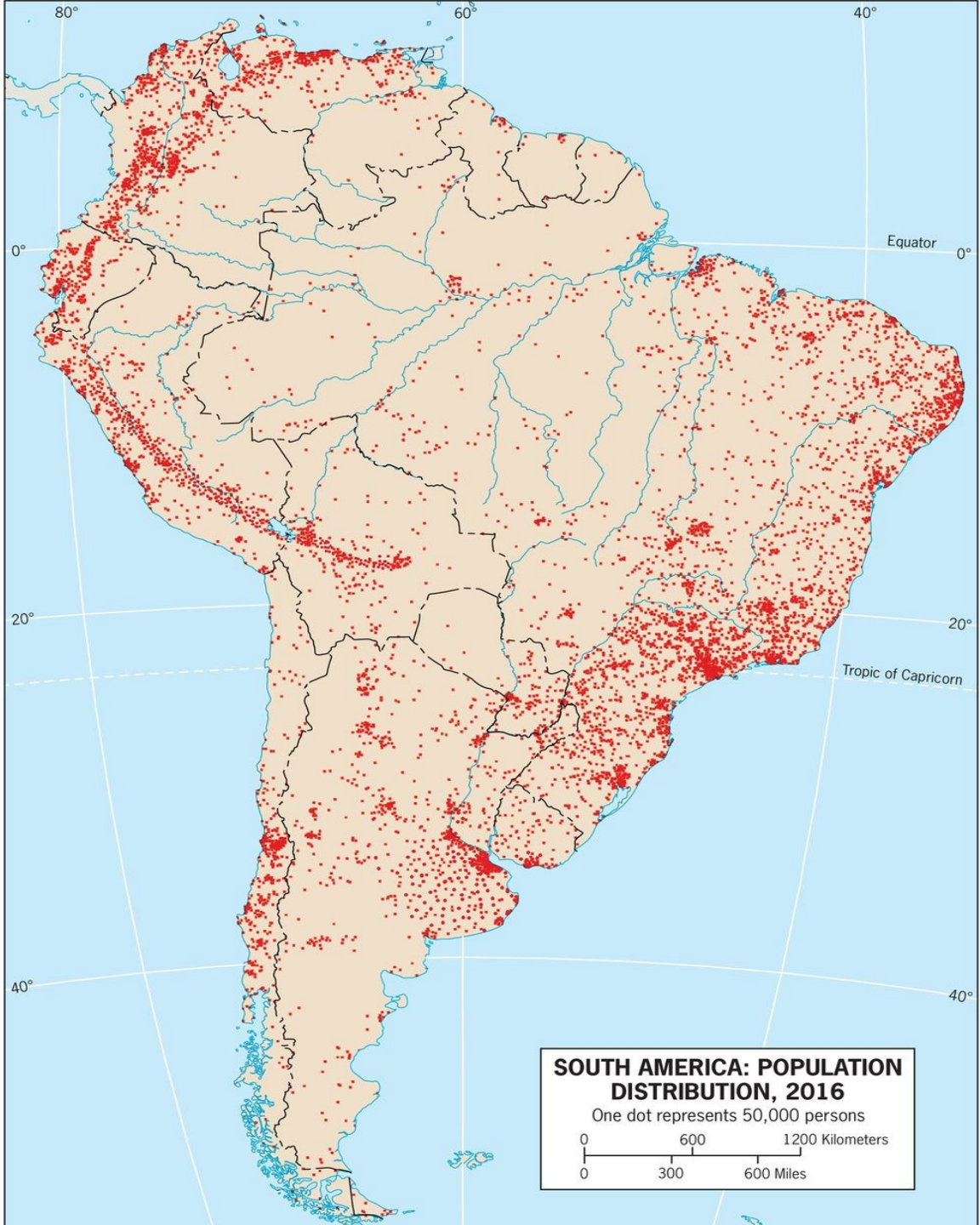
- Various symbols (e.g., dot, triangle, star) represent features that occur at particular points in space; e.g. village, church, school
- Two kinds of point symbol maps that show variation in quantity
  - **Dot maps**
    - Each dot represents a given quantity
  - **Graduated symbol maps**
    - Size of symbol varies according to quantities represented

© McGraw Hill

# THE SOUTH AMERICAN REALM
## THE CULTURAL MOSAIC

# Point symbols
# Dot maps

- The Population Map—Then and Now
- "Pre-Colombian" population
  - Indigenous societies inhabited Andes highlands, Amazon Basin, and harsh environments of Tierra del Fuego
- Contemporary population
  - 90% of indigenous peoples eradicated by European warfare and disease
  - European settlers stayed near the coasts
- Andes settlements legacy of Incas




J. Nijman, P. O. Muller, H. J. de Blij, and John Wiley & Sons, Inc.

© McGraw Hill

# THE SOUTH AMERICAN REALM
# URBANIZATION

## Graduated symbol maps

### Rural-Urban Migration

Urban population of 82%

**Rural-to-urban migration**—from countryside to cities

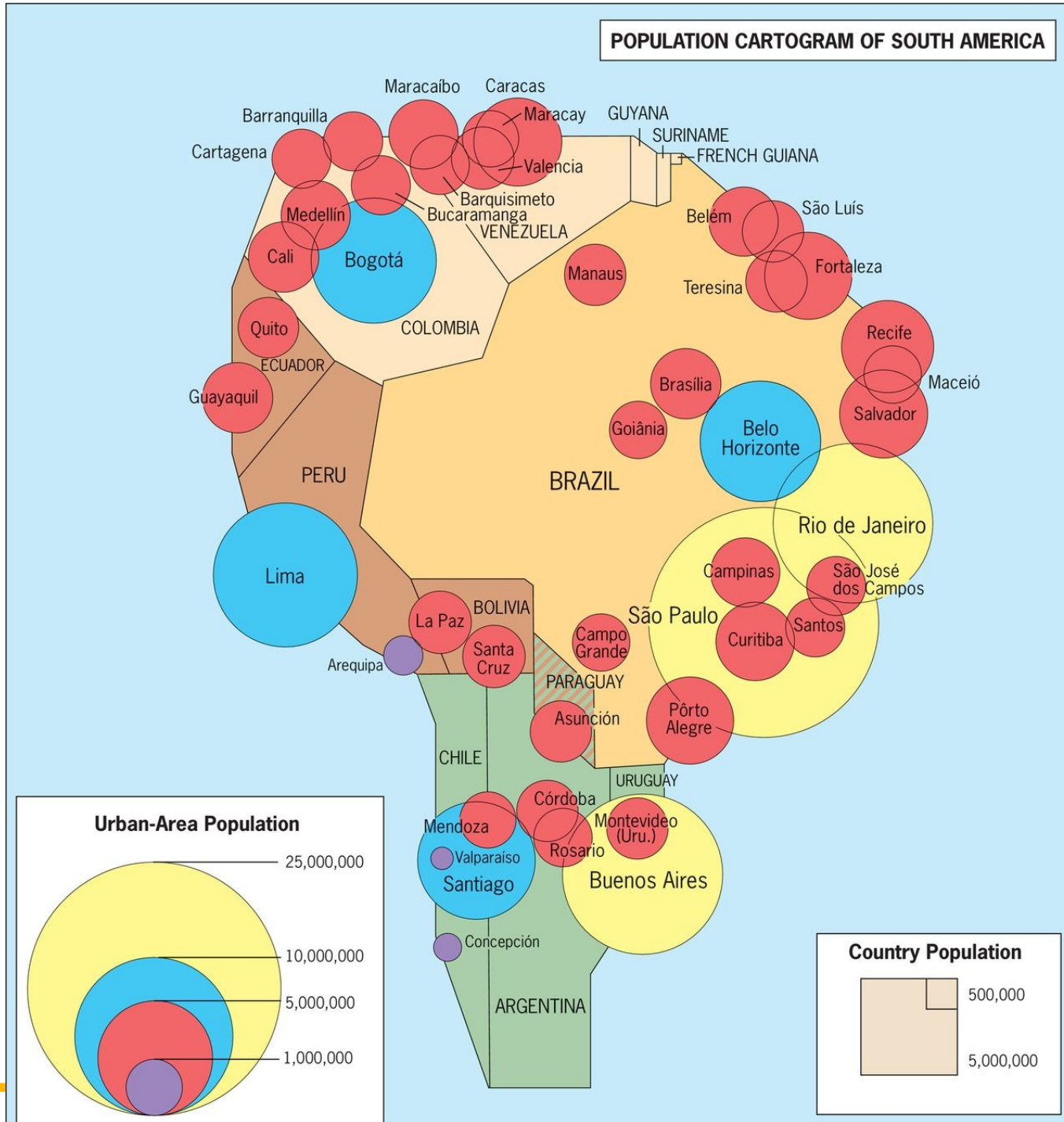
**Push and Pull factors**

Push Factors

- Slow rural land reforms
- Little prospect of economic advancement

Pull Factors

- Urban opportunities—regular wages, education for children
- Better medical care
- Upward social mobility and lure of life in a big city




© McGraw Hill

# Types of Maps: Thematic Maps and Data Representation (3)

## Area symbols

- Different colors or patterns represent features found within defined areas (e.g., counties, states, countries) of the earth's surface
- Can show differences in kind
  - **Different colors** are used for different entities
  - E.g., religions, languages, vegetation,

© McGraw Hill

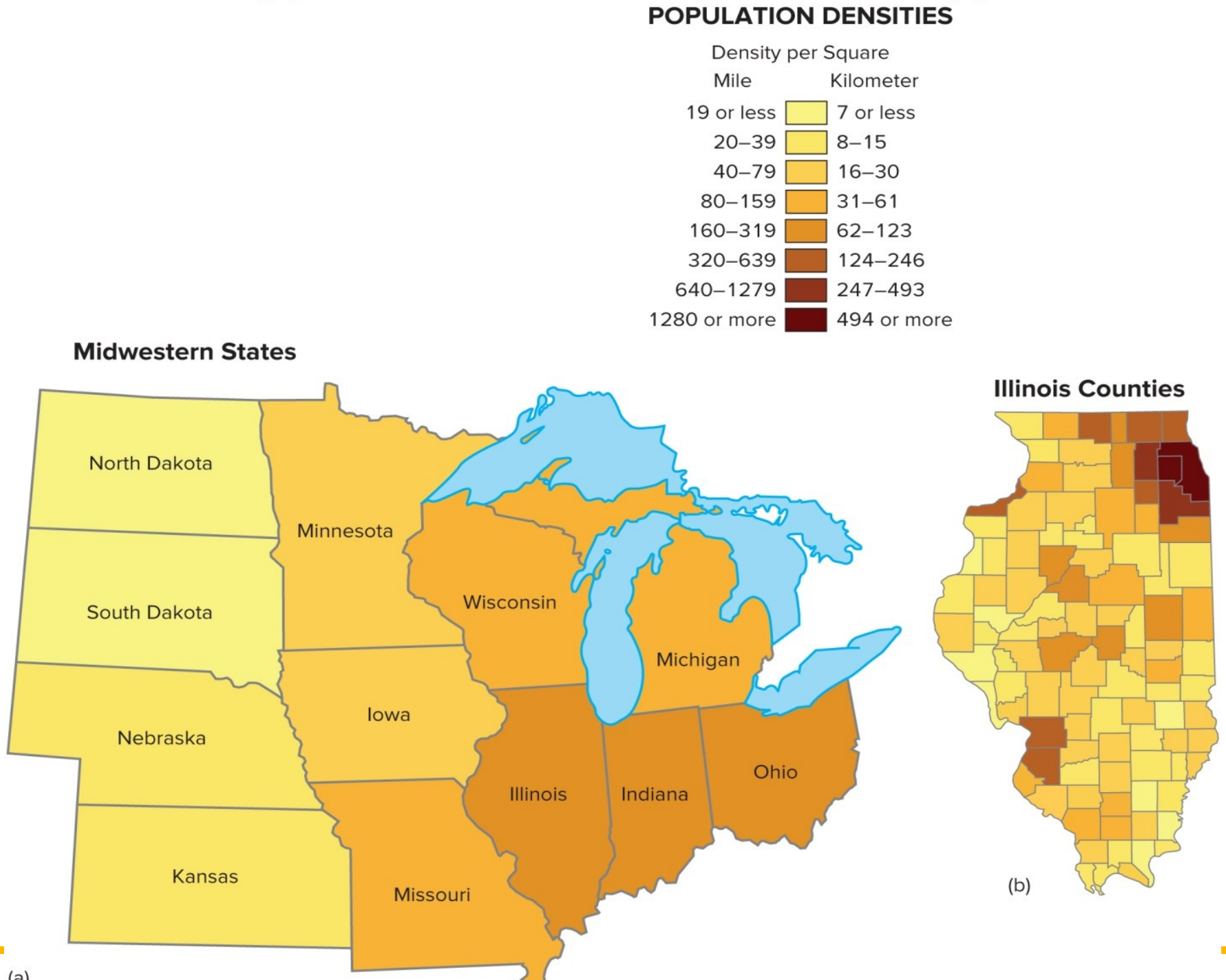
ARCTIC OCEAN
GREENLAND
NORTH ATLANTIC OCEAN
RUSSIA
EUROPE
KAZAKHSTAN
MONGOLIA
CHINA
INDIA
PACIFIC OCEAN
ALGERIA
LIBYA
EGYPT
SAUDI ARABIA
IRAN
MALI
NIGER
CHAD
SUDAN
NIGERIA
SOUTH SUDAN
ETHIOPIA
SOMALIA
ANGOLA
NAMIBIA
SOUTH AFRICA
MADAGASCAR
AUSTRALIA
INDIAN OCEAN
SOUTH AMERICA
BRAZIL
ARGENTINA
CHILE
SOUTH ATLANTIC OCEAN
ANTARCTICA

# Types of Maps: Thematic Maps and Data Representation (4)

**Area symbols** (continued)

- Can show differences in **quantity**
  - Choropleth map
    - Shows how amount varies from area to area
    - Data are grouped into classes, each represented by a **distinctive color**, **shade**, or

© McGraw Hill


POPULATION DENSITIES
Density per Square
Mile
Kilometer
19 or less
7 or less
20–39
8–15
40–79
16–30
80–159
31–61
160–319
62–123
320–639
124–246
640–1279
247–493
1280 or more
494 or more
Midwestern States
North Dakota
Minnesota
South Dakota
Wisconsin
Michigan
Nebraska
Iowa
Illinois
Indiana
Ohio
Kansas
Missouri
(a)
Illinois Counties
(b)

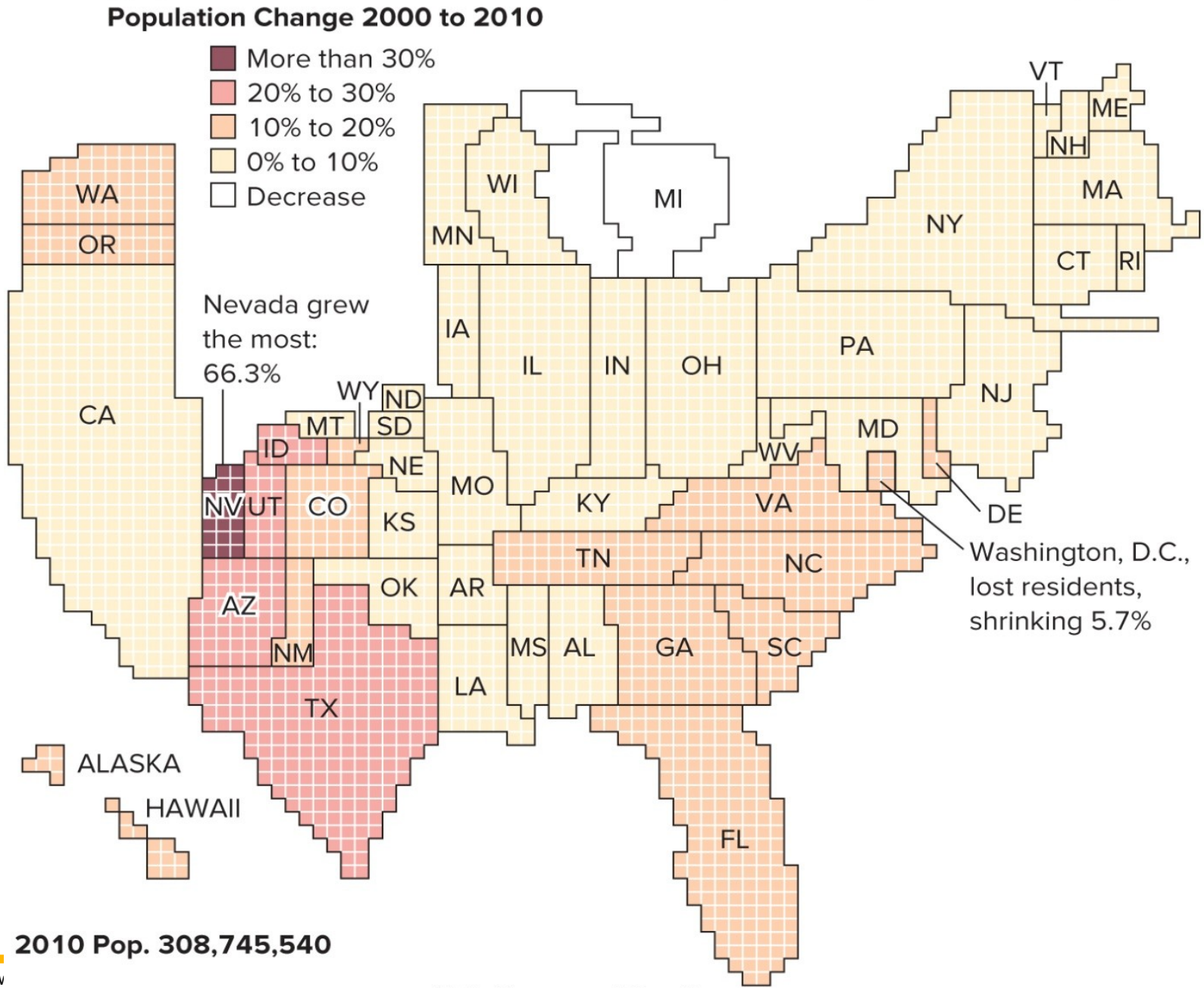
# Types of Maps: Thematic Maps and Data Representation (5)

**Area symbols** (continued)

- Can show differences in **quantity**
  - **Area cartogram (value-by-area map)**
    - **Areas** of units are ***drawn proportional*** to the data they represent
    - **Sizes and shapes of areas may be altered**
    - ***Distances and directions may be distorted***
    - Contiguity may not be preserved

© McGraw Hill

# Cartogram



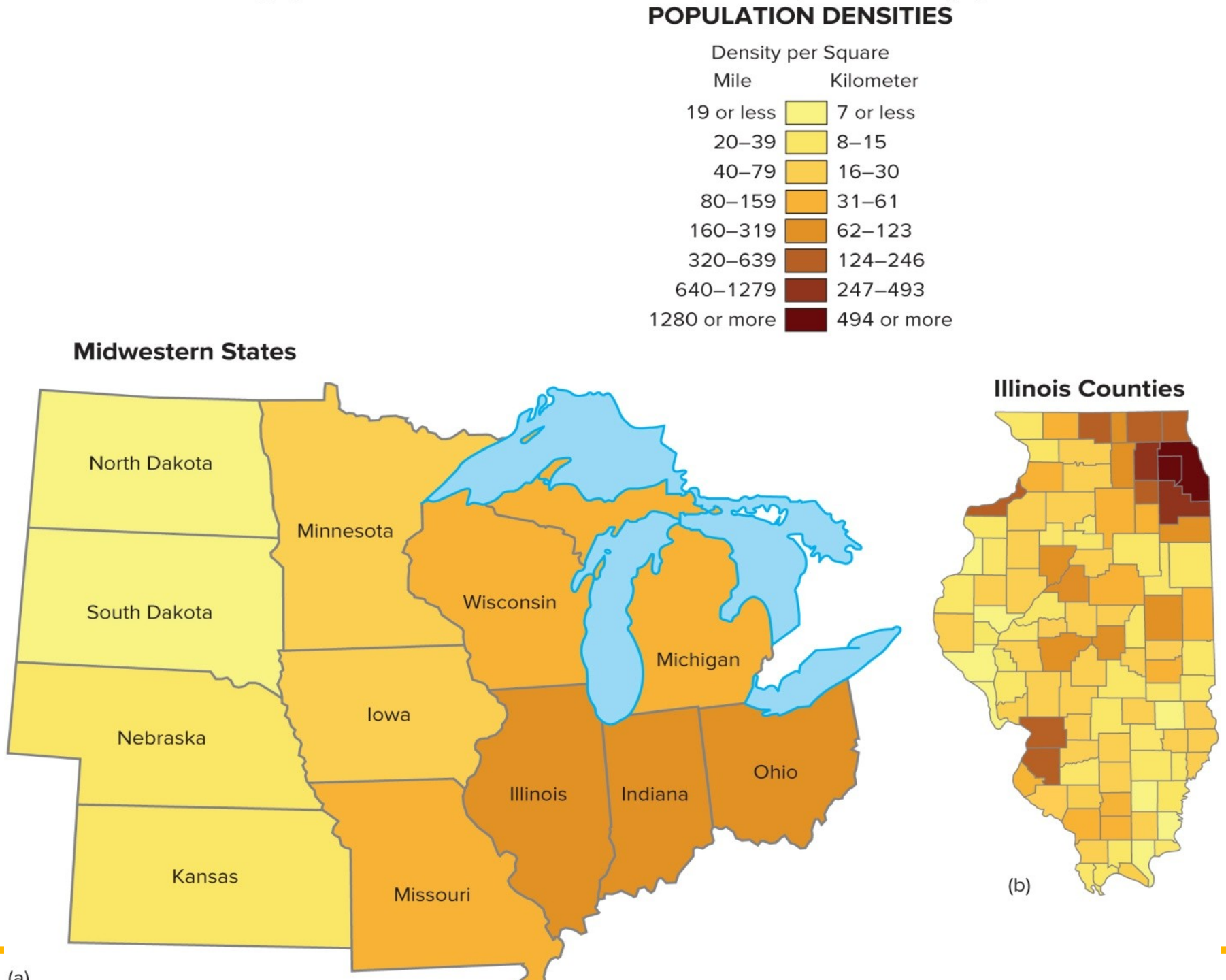

© McGrav

# Types of Maps: Thematic Maps and Data Representation (6)

Three main problems characterize maps that show distribution of a phenomenon in an area:

- Give ***impression of uniformity*** to areas that may contain significant variations
- Boundaries **imply abrupt changes** between areas when **changes may be gradual**
- *Unless colors are chosen wisely, some areas may look more important than* ***others this is often done on purpose***

© McGraw Hill


POPULATION DENSITIES
Density per Square
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80–159
31–61
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247–493
1280 or more
494 or more
Midwestern States
North Dakota
Minnesota
South Dakota
Wisconsin
Michigan
Nebraska
Iowa
Illinois
Indiana
Ohio
Kansas
Missouri
(a)
Illinois Counties
(b)

# Types of Maps: Thematic Maps and Data Representation (7)

## Line symbols

- Represent features that have length but insignificant width
  - E.g., roads, railroads, political boundaries
- **Isoline** maps
  - Include numerical values
  - Isoline = Line of constant value
    - E.g., isohyets (equal rainfall), **isotherms** (equal temperature), **isobars** (equal barometric pressure)

© McGraw Hill

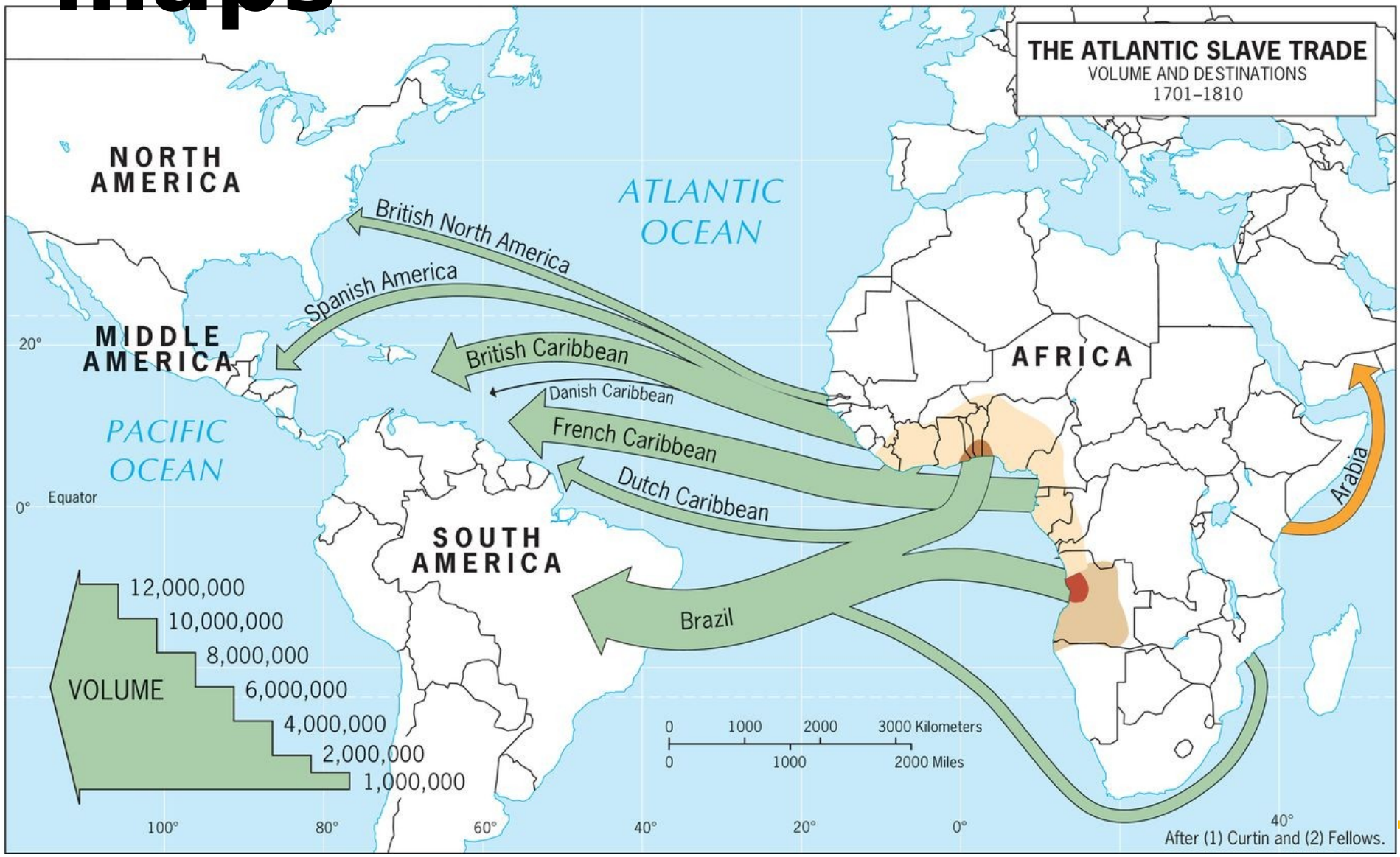
# Types of Maps: Thematic Maps and Data Representation (8)

## Line symbols

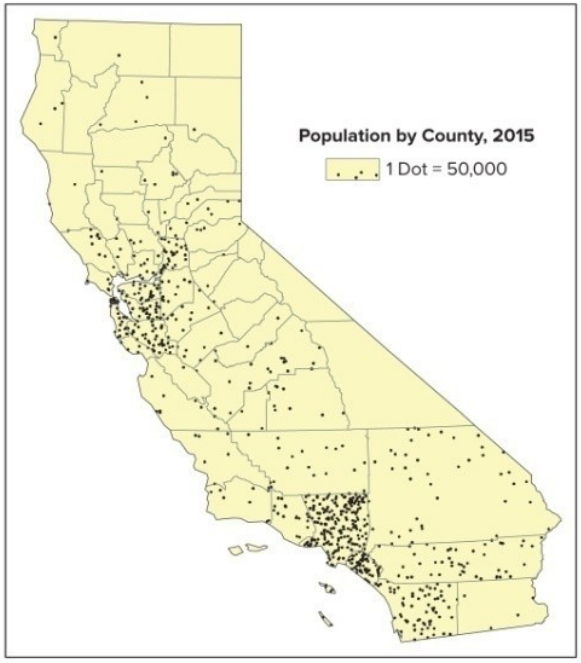
- ***Qualitative flow-line maps***
  - Portray **linear movement** between places
  - Generally have ***arrows indicating direction of movement***
  - E.g., ocean currents, airline routes
- ***Quantitative flow-line maps***
  - Flow lines have varying **proportional widths** representing **volumes of flow**
  - May also *depict route taken* and ***direction of movement***
  - E.g., migration, traffic, commodity flows

© McGraw Hill

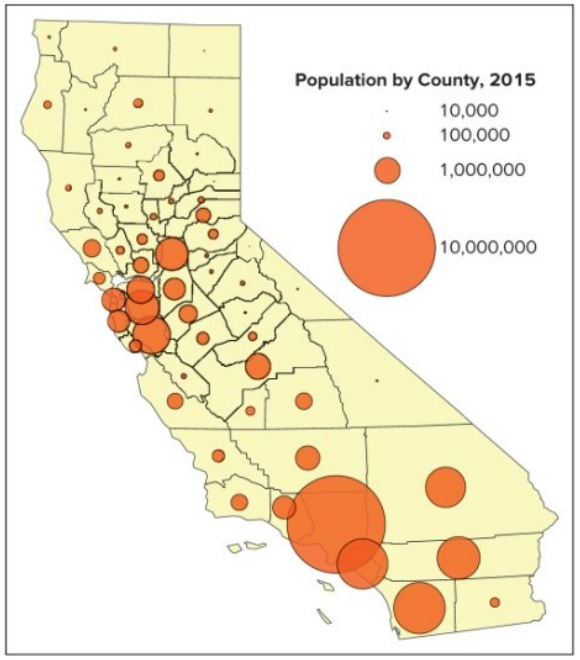
# Quantitative flow-line maps



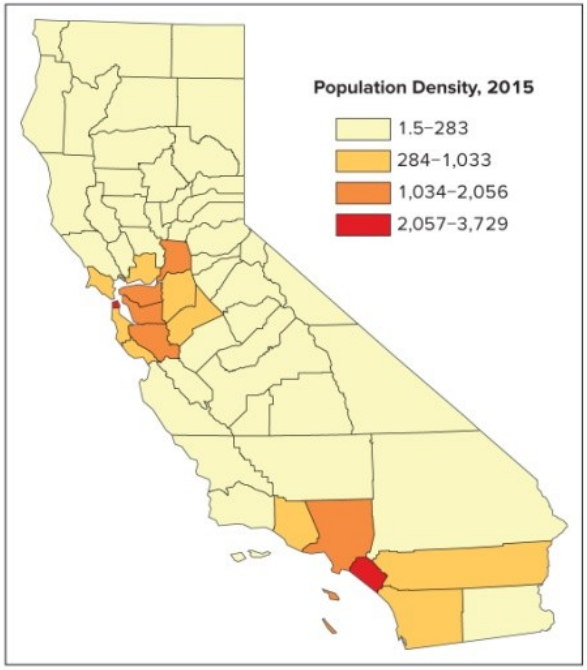
# Types of Maps




(a)




(b)




(c)

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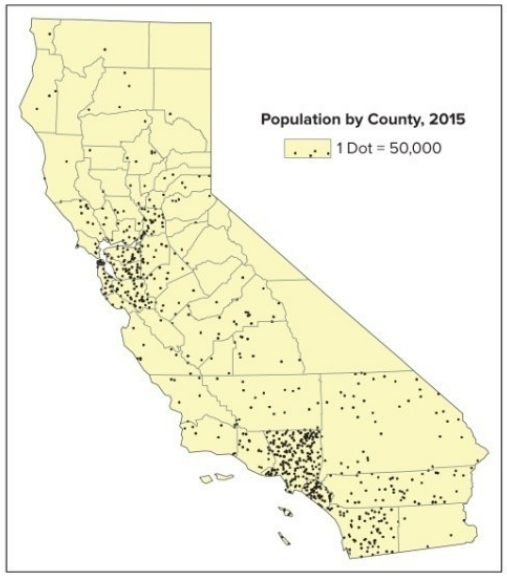
# Population Maps

Although population is the theme of each, these different California maps present their information in strikingly different ways.

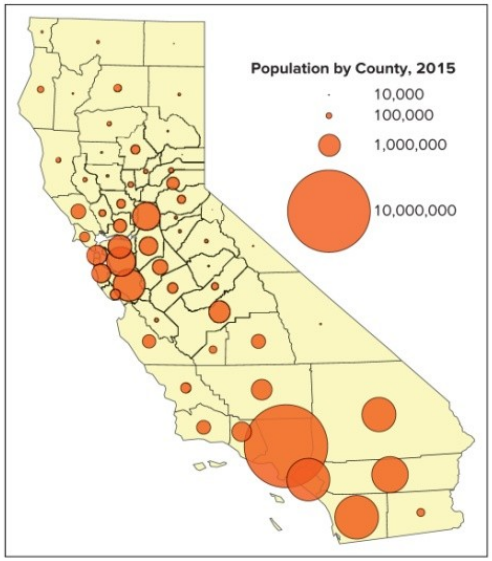
a) In **a Dot-Distribution** map where large numbers of items are involved, the value or each dot is identical and stated in the map legend. The placement of dots on the map does not indicate precise locations of people within the county, but simply their total number.

b) In the **Graduated Circle map**, the area of the circle is approximately proportional to the absolute number of people within each county.

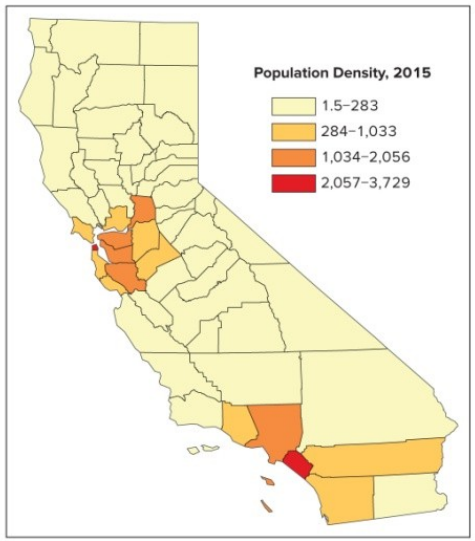
c) This is a **Choropleth map** that shows population density by county. Quantitative variation by area is more easily visualized in a map than in a table.



(a)

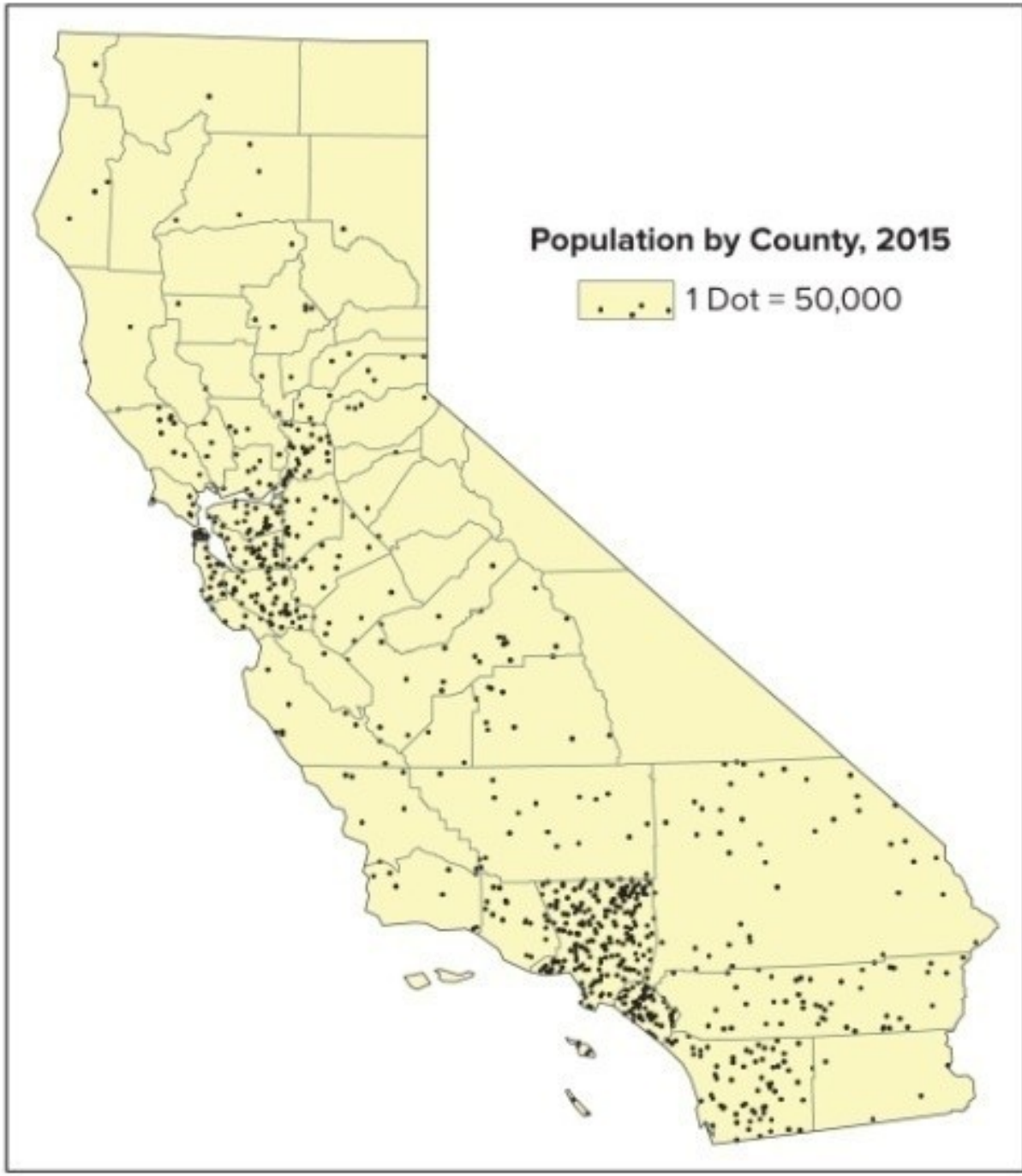


(b)



(c)

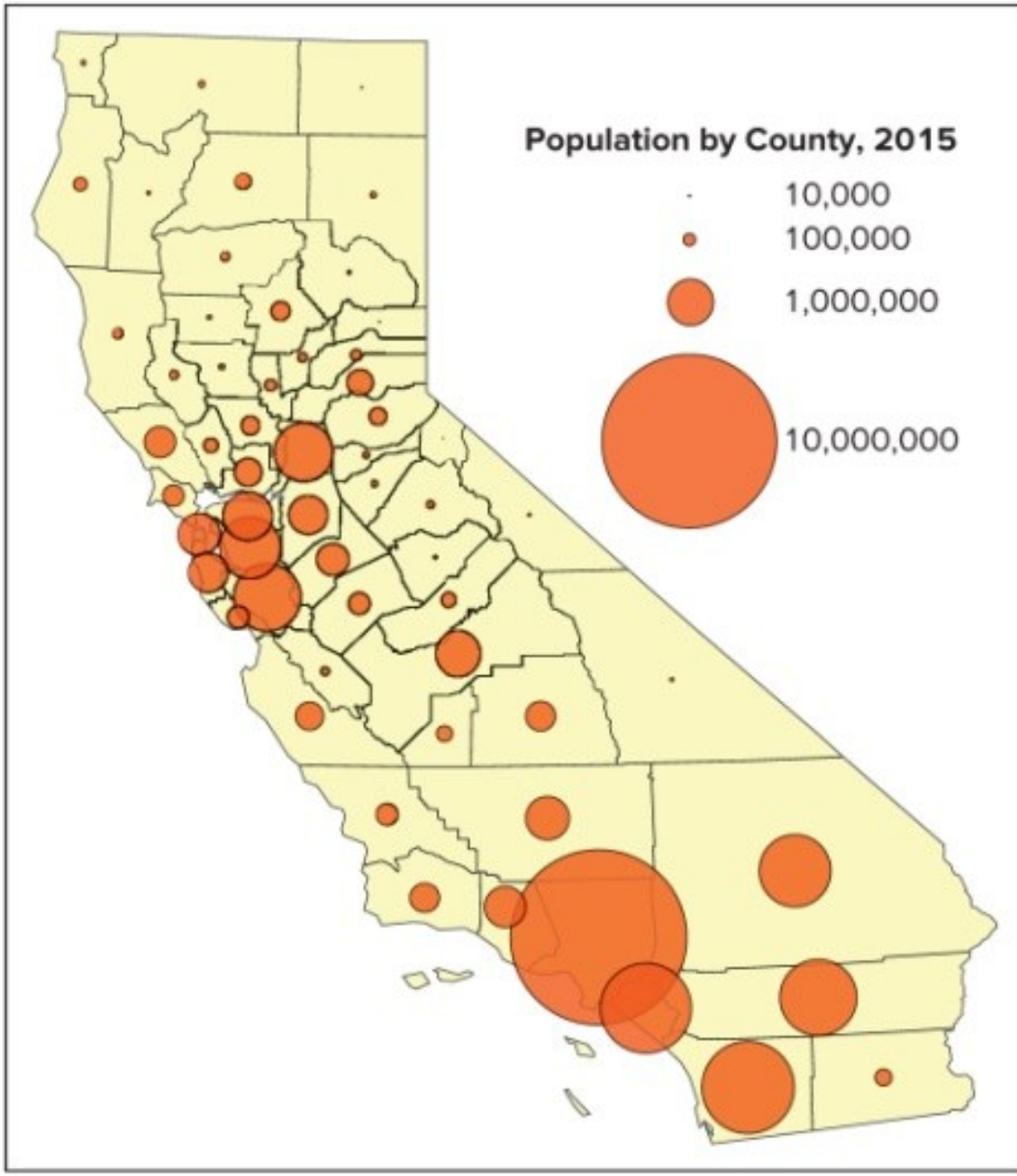
a)In **a Dot-Distribution** map where large numbers of items are involved, the value or each dot is identical and stated in the map legend. The placement of dots on the map does not indicate precise locations of people within the county, but simply their




(a)

© McGraw-Hill

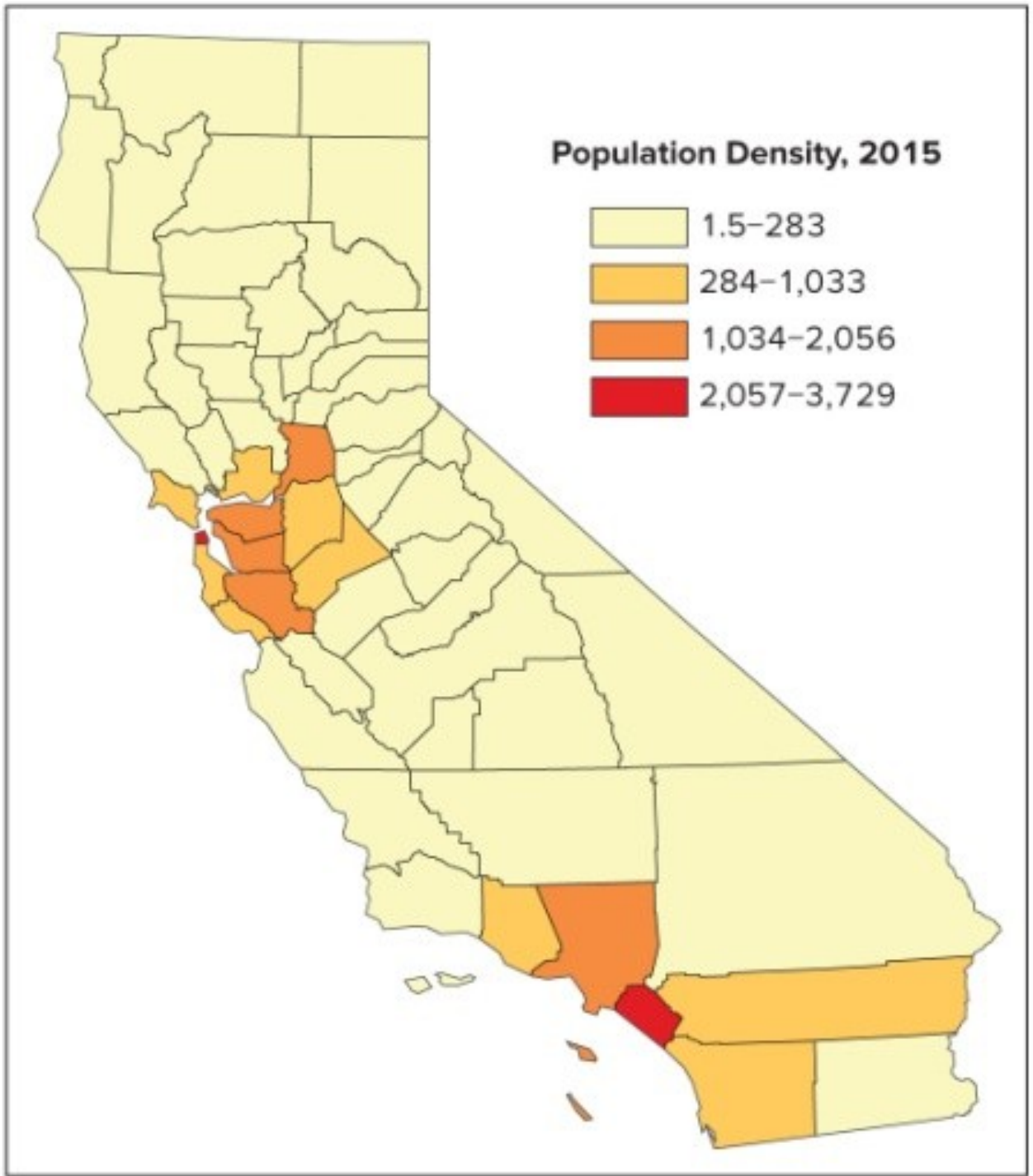
In the **Graduated Circle map**, the area of the circle is approximatel y proportional to the absolute number of people within each




(b)

© McGraw-Hill

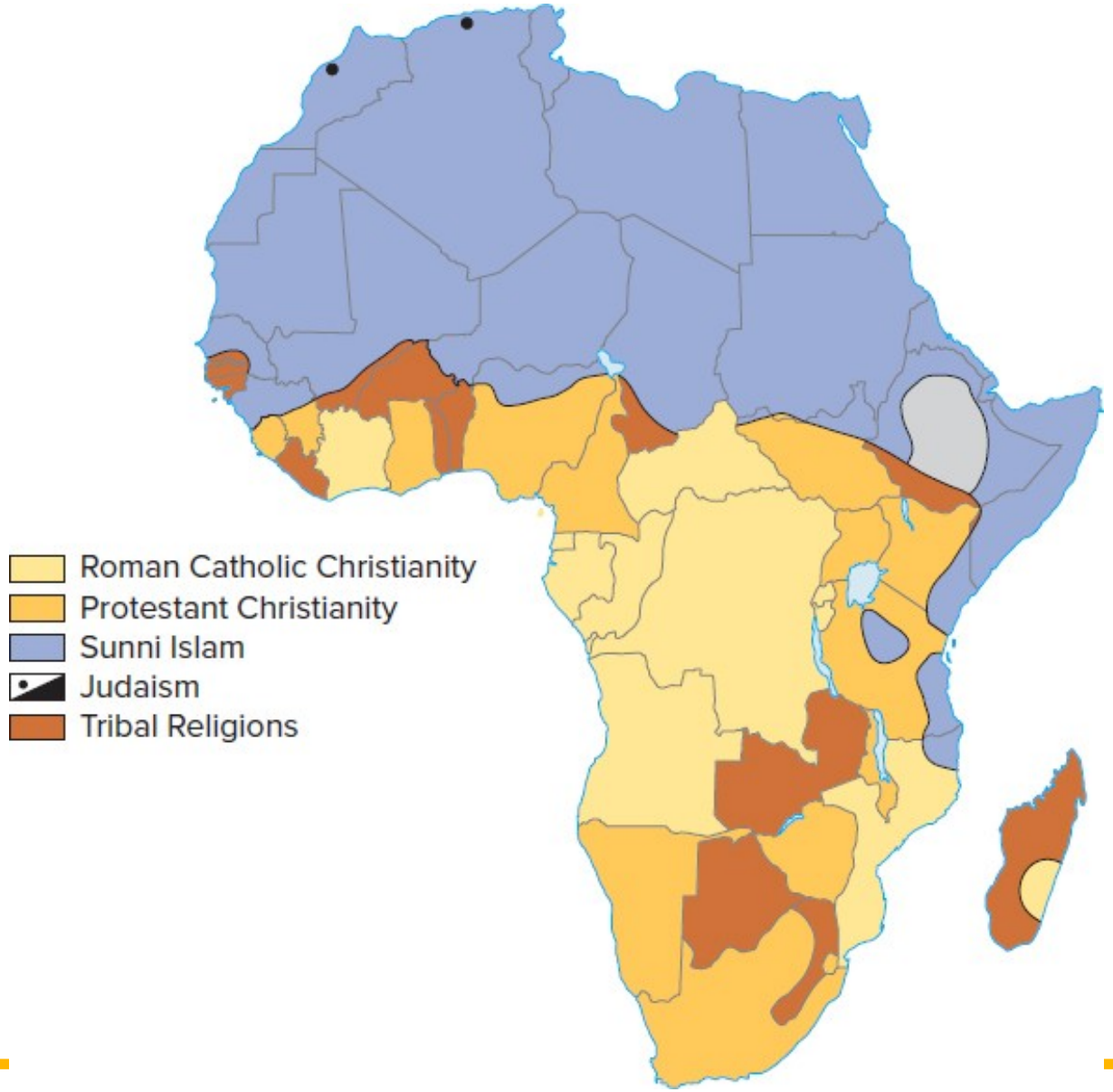
a)This is a **Choropleth map** that shows population density by county. Quantitative variation by area is more easily visualized in a map than in a table.




© McGraw Hill

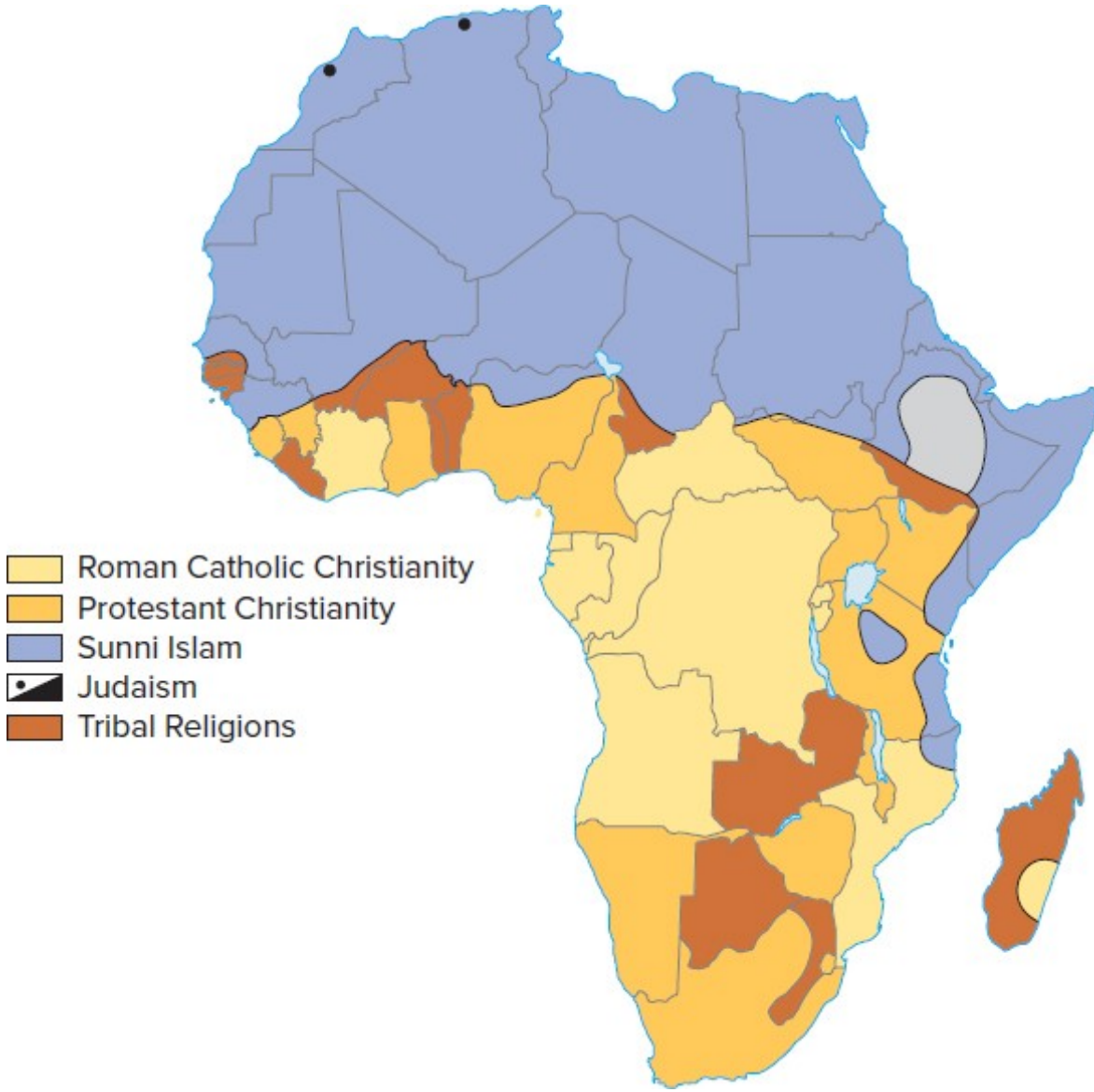
# Religious Regions of Africa

## A Choropleth map



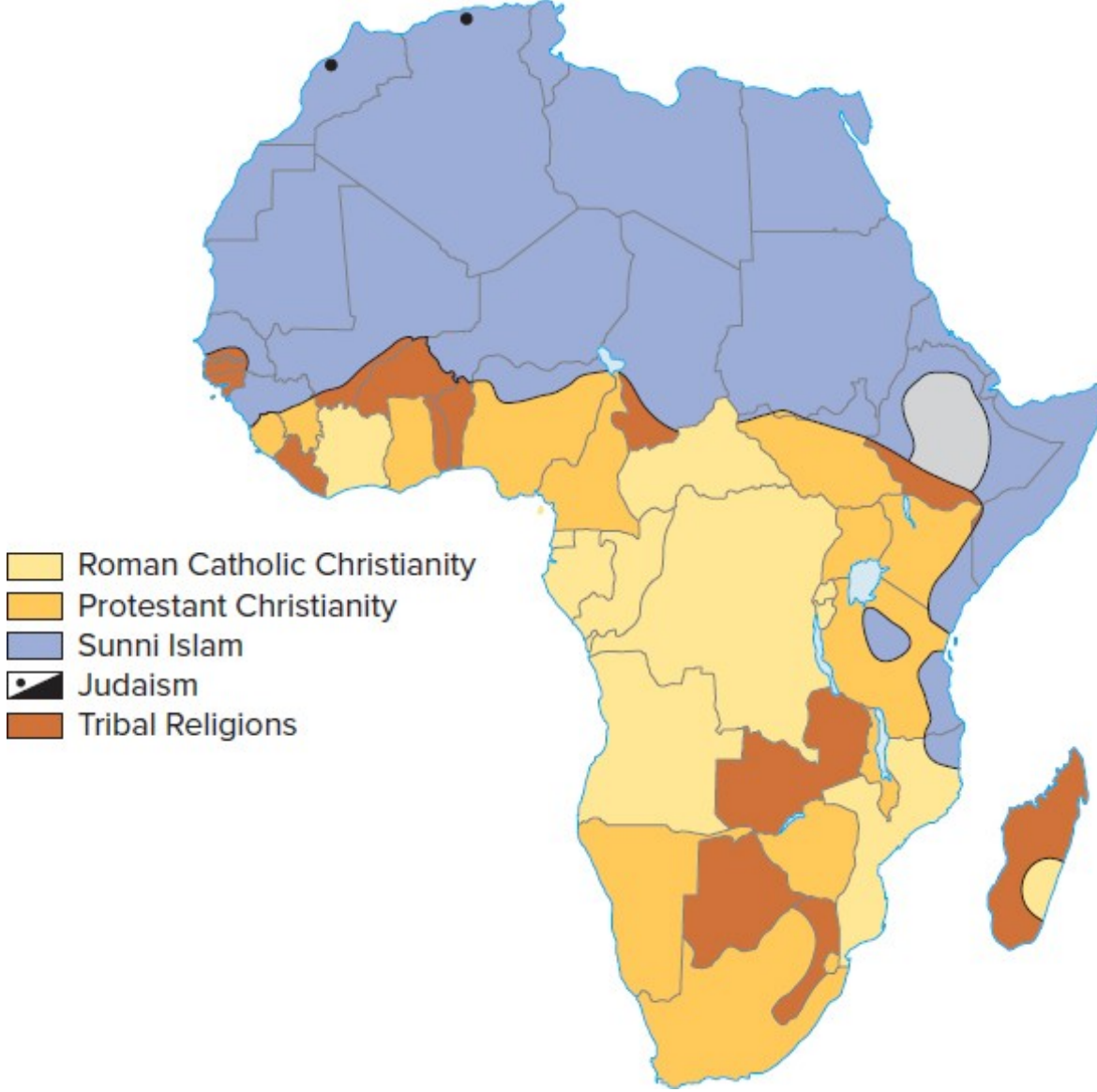

© McGraw Hill

There are 5 regions on the map: Sunni Islam covers the entire Northern part of Africa and extends till the center. The second largest region consists of the Roman catholic Christianity, the third is protestant Christianity, next is tribal religions and finally there are small pockets of



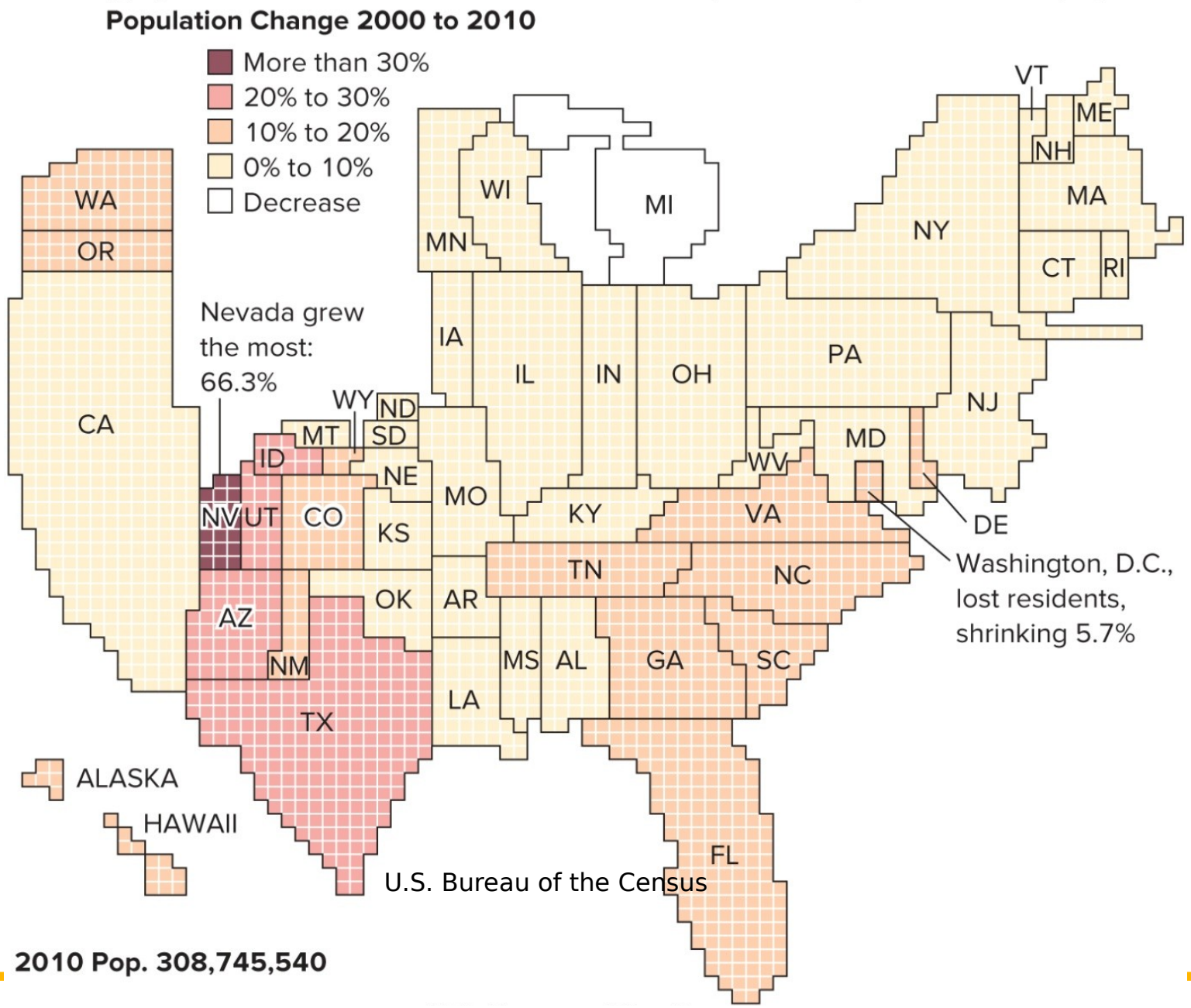

© McGraw Hill

Religious regions of Africa. Maps such as this one *may give the* ***false impression of uniformity*** *within a given area*—for example, that only Christianity is followed in much of southern Africa. Such maps are intended to ***represent only the predominant religion in an***




© McGraw-Hill

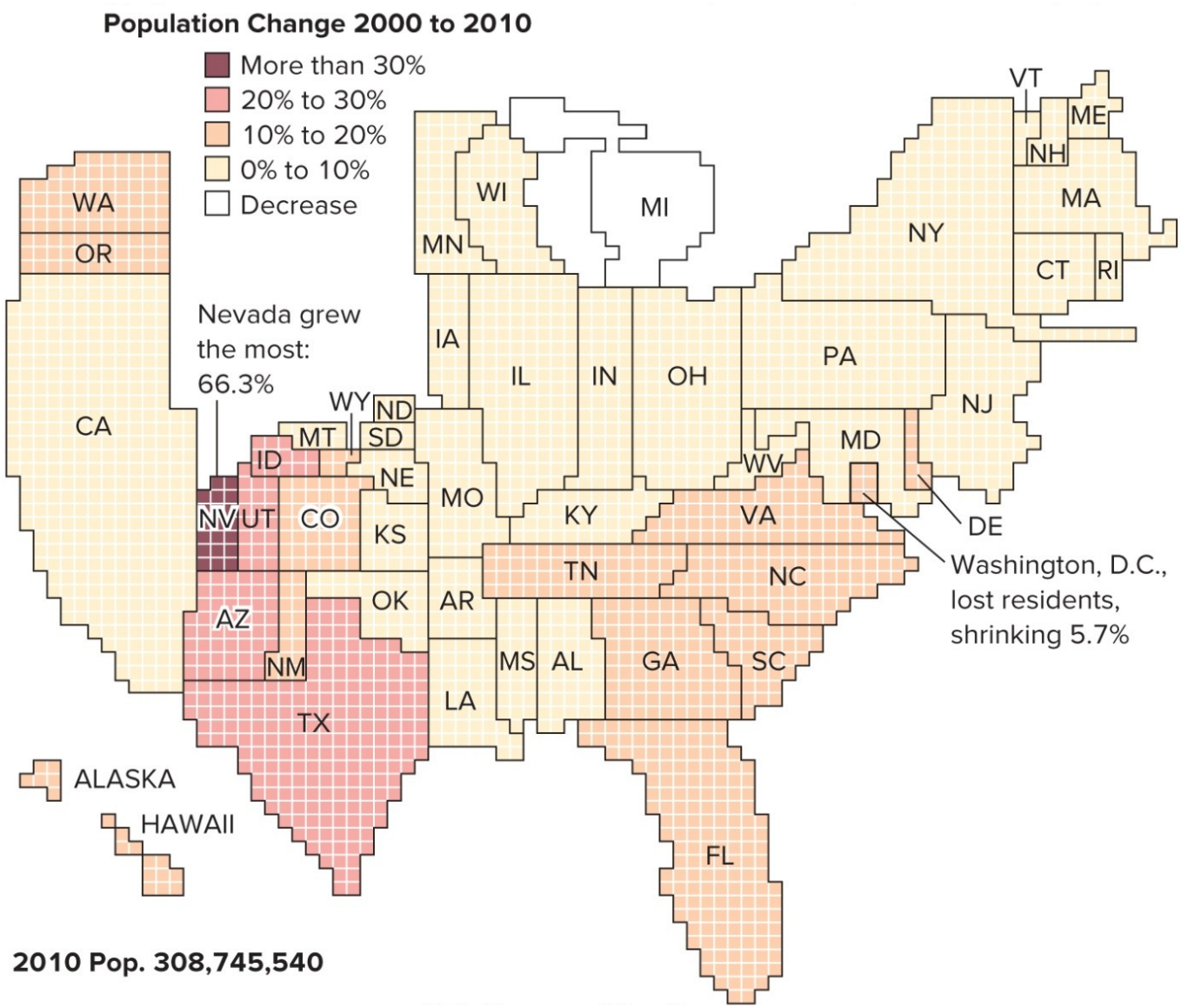
# Cartogram




© McGraw Hill

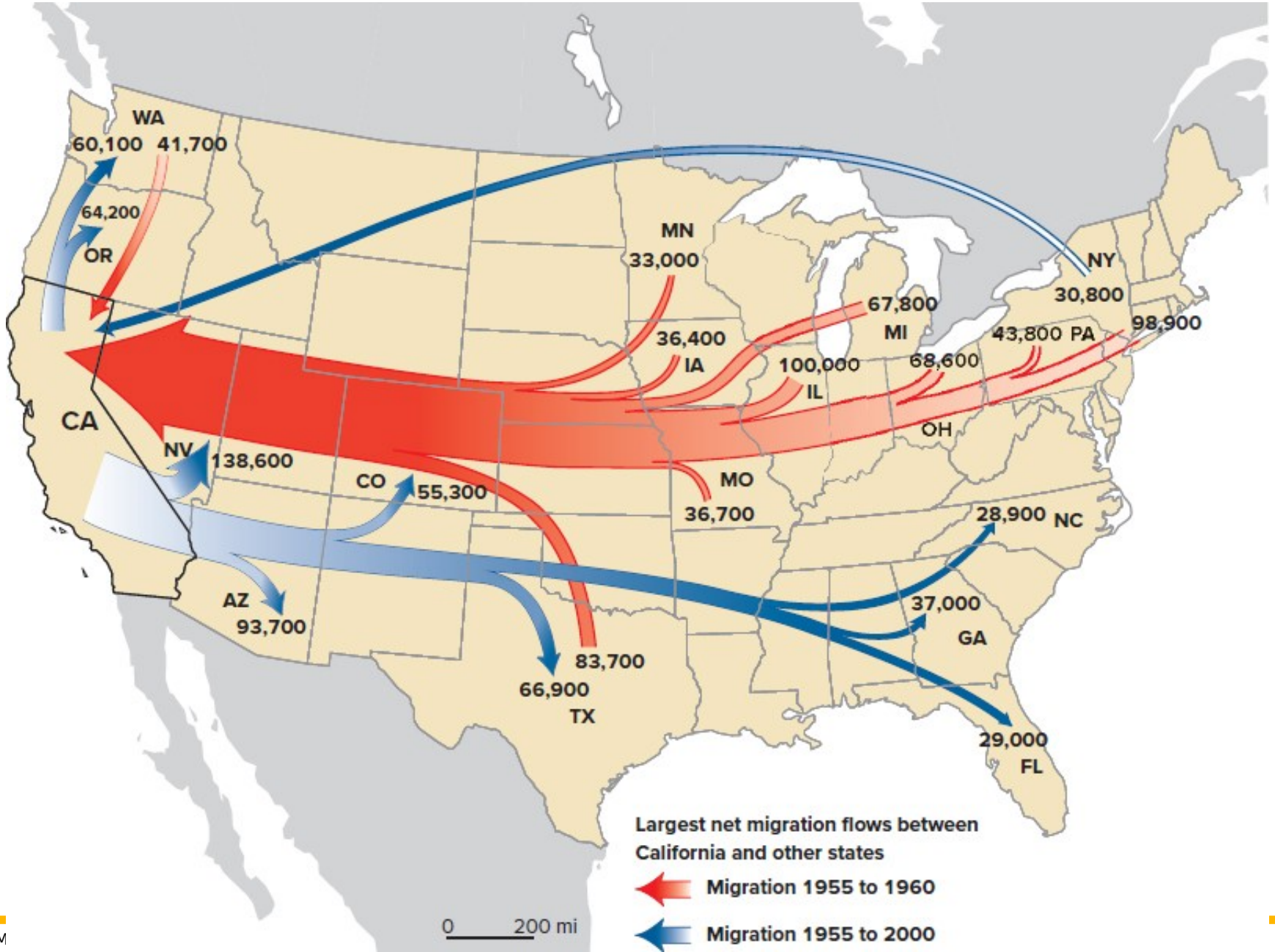
# Cartogram

A cartogram in which each *state is* ***sized according to its number of residents*** *in the year 2010 as* reported by the U.S. Bureau of the Census. The cartogram also shows the percentage change in population between 2000 and 2010. Source: U.S. Bureau of the Census.



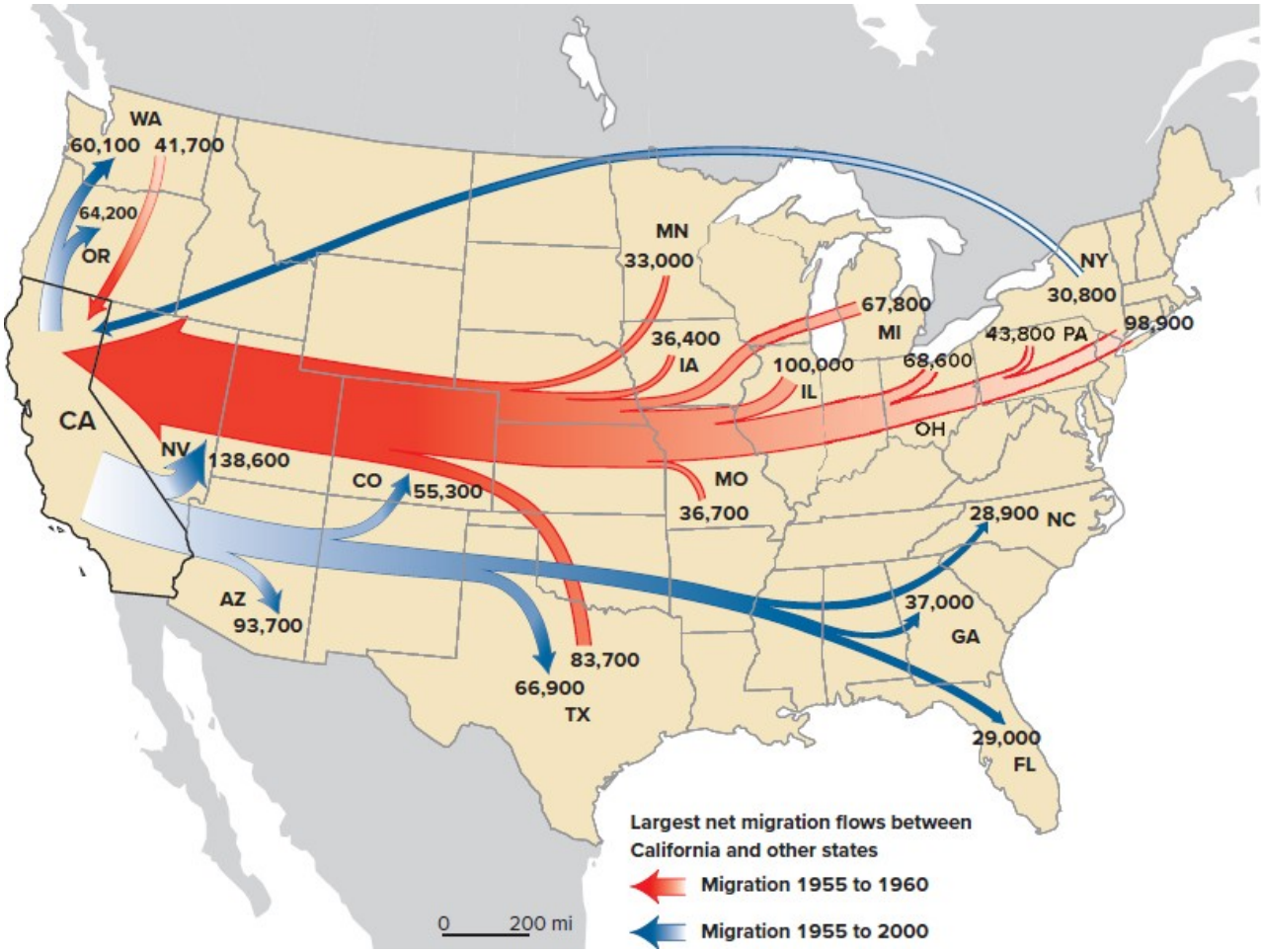

© McGraw Hill

# Quantitative Flow-line Map



# Quantitative Flow-line Map

The map indicates that the **largest net migration flows between California and other states.** The migration between **1955 to 1960 into California from different states is as follows:** WA, 41,700; TX, 52,000; MO, 36,700; MN, 22,000; IA, 26,400; IL, 100,000; MI, 67,600; PA, 42,800. The **migration from California to other states between 1955 to 2000 is as** follows: OR, 24,200; WA, 60,100; NV,




© McGraw Hill

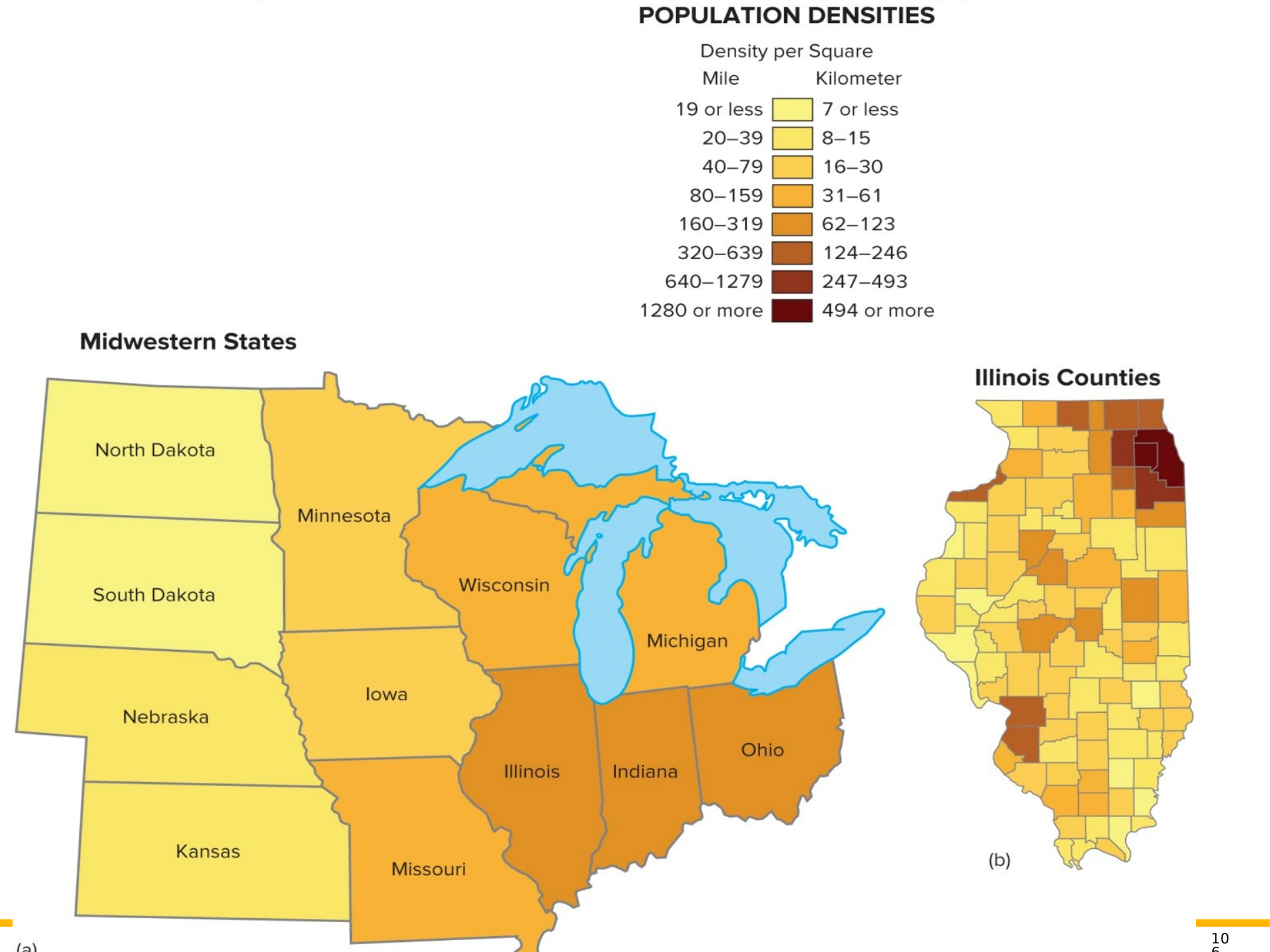
# Types of Maps: Map Misuse (1)

Message conveyed by a map reflects the intent and, perhaps, **biases** of its author

Techniques for making **misleading maps**

- Lack of a **scale**
- Simple design that **omits data** or features
- **Colors** with a strong psychological impact
- Bold, oversized, and/or misleading **symbols**
- **Action symbols**
- Selective **omission of data**
- **Disinformation**
- **Inappropriate projection**

© McGraw-Hill


POPULATION DENSITIES
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1280 or more
494 or more
Midwestern States
North Dakota
Minnesota
South Dakota
Wisconsin
Michigan
Nebraska
Iowa
Illinois
Indiana
Ohio
Kansas
Missouri
(a)
Illinois Counties
(b)

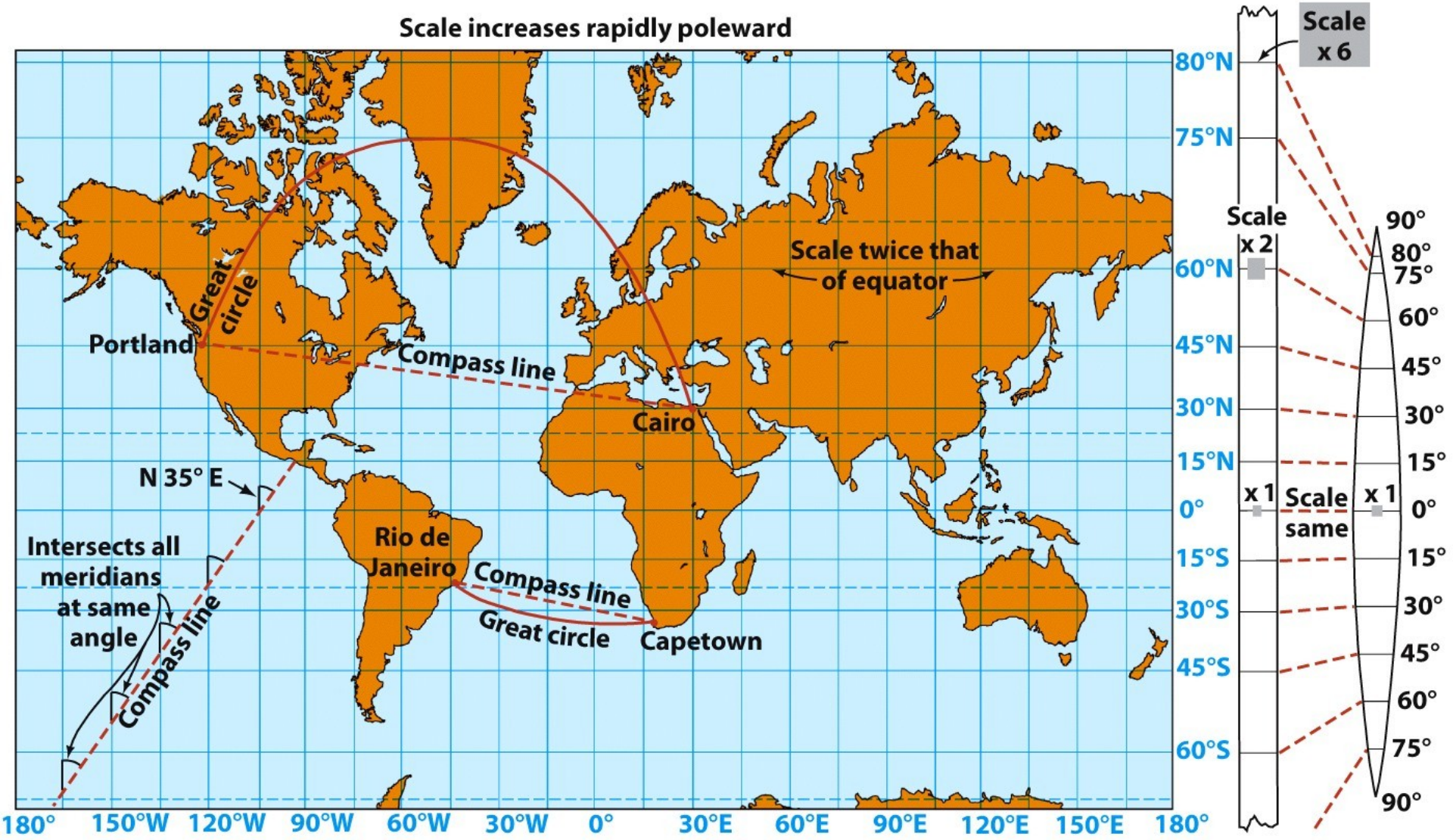


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Figure 1.11 part 1

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# Equidistant Projection

a)Azimuthal equidistant projection, polar case

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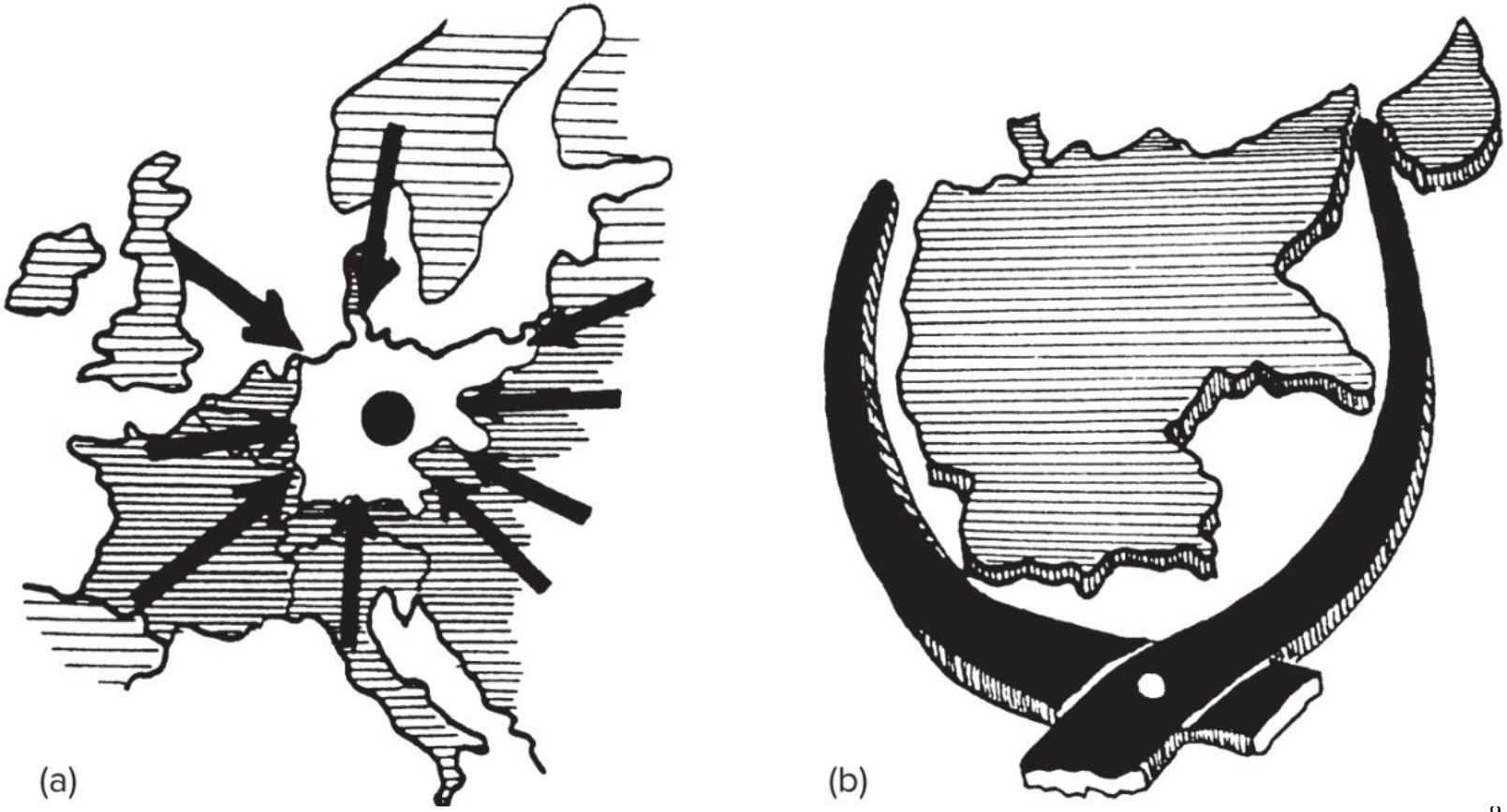
# Types of Maps: Map Misuse (2)

Thus, important for map users to understand the concepts of map projections and map symbolizations, and the common forms of thematic and reference mapping standards.



(a) (b)

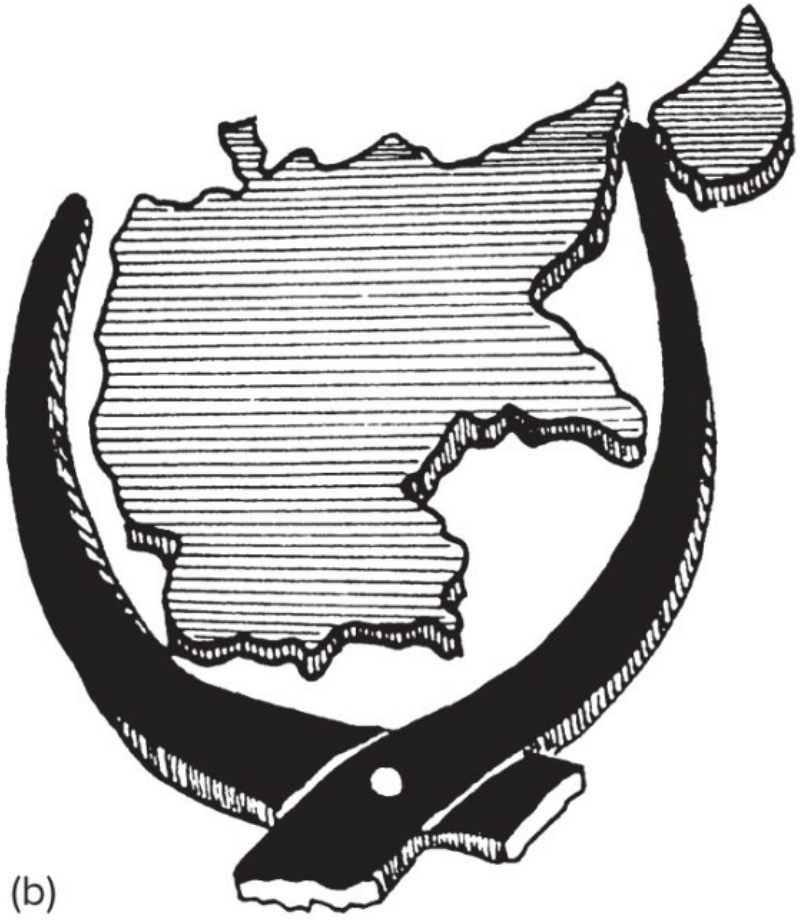
© McGraw Hill

# Types of Maps: Map Misuse (2)

The Nazis, who ruled Germany from 1933 to 1945, used maps as tools of propaganda. The maps shown here were designed to increase sympathy for Germany by showing it threatened by encirclement.

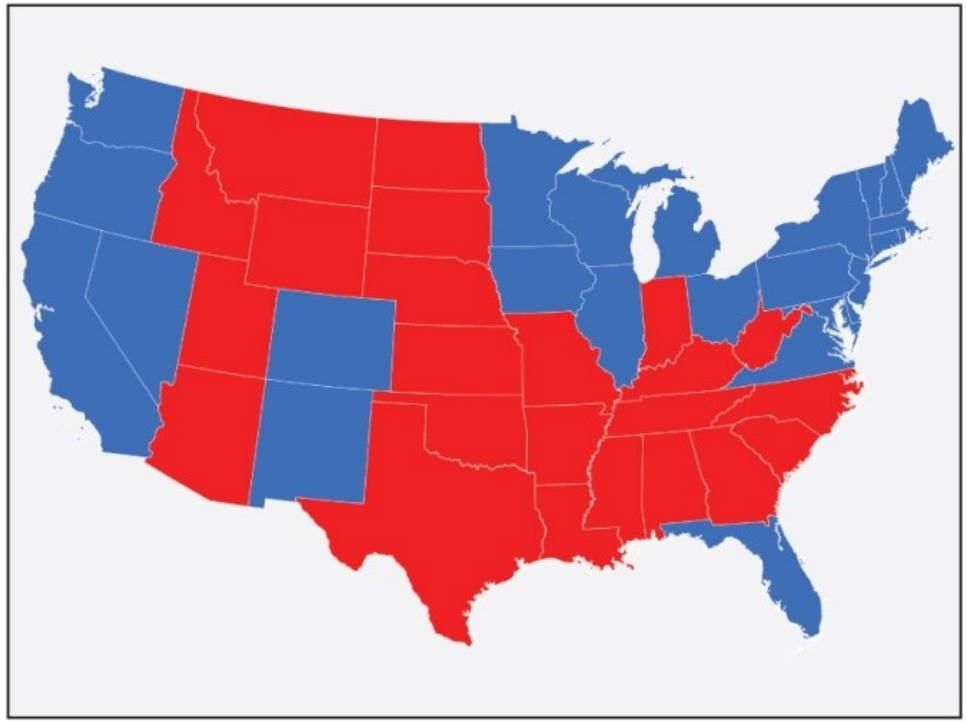
***a)Arrows represent pressure*** on Germany from all sides.

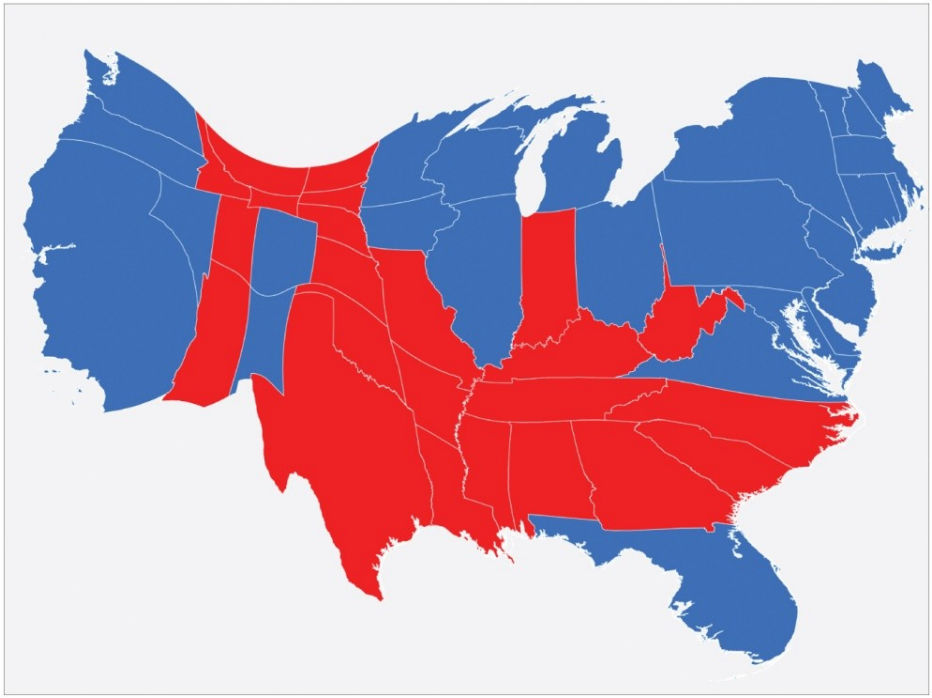
***b)Pincers*** signify pressure against Germany from France and Poland.



# Conventional View vs. Population Cartogram

2012 presidential election results



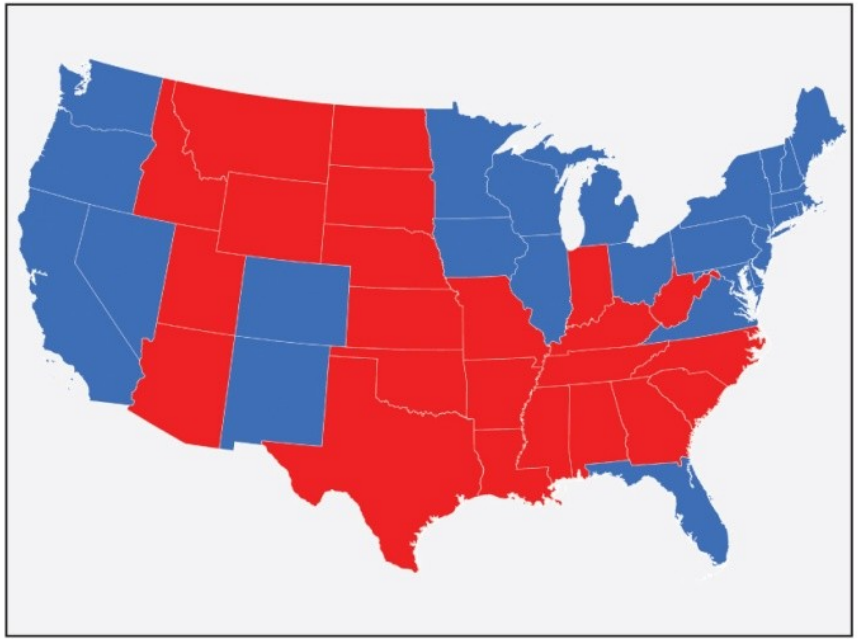


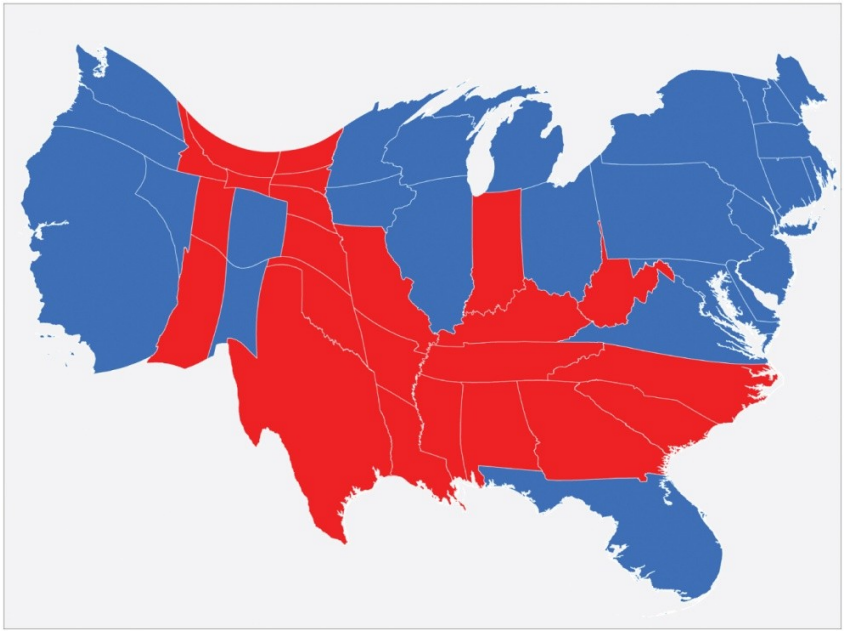
© McGraw Hill

# Cartogram

a)Conventional view. This map of the November 2012 presidential election shows state-by-state results, colored red and blue to indicate Republican and Democratic majorities, respectively.

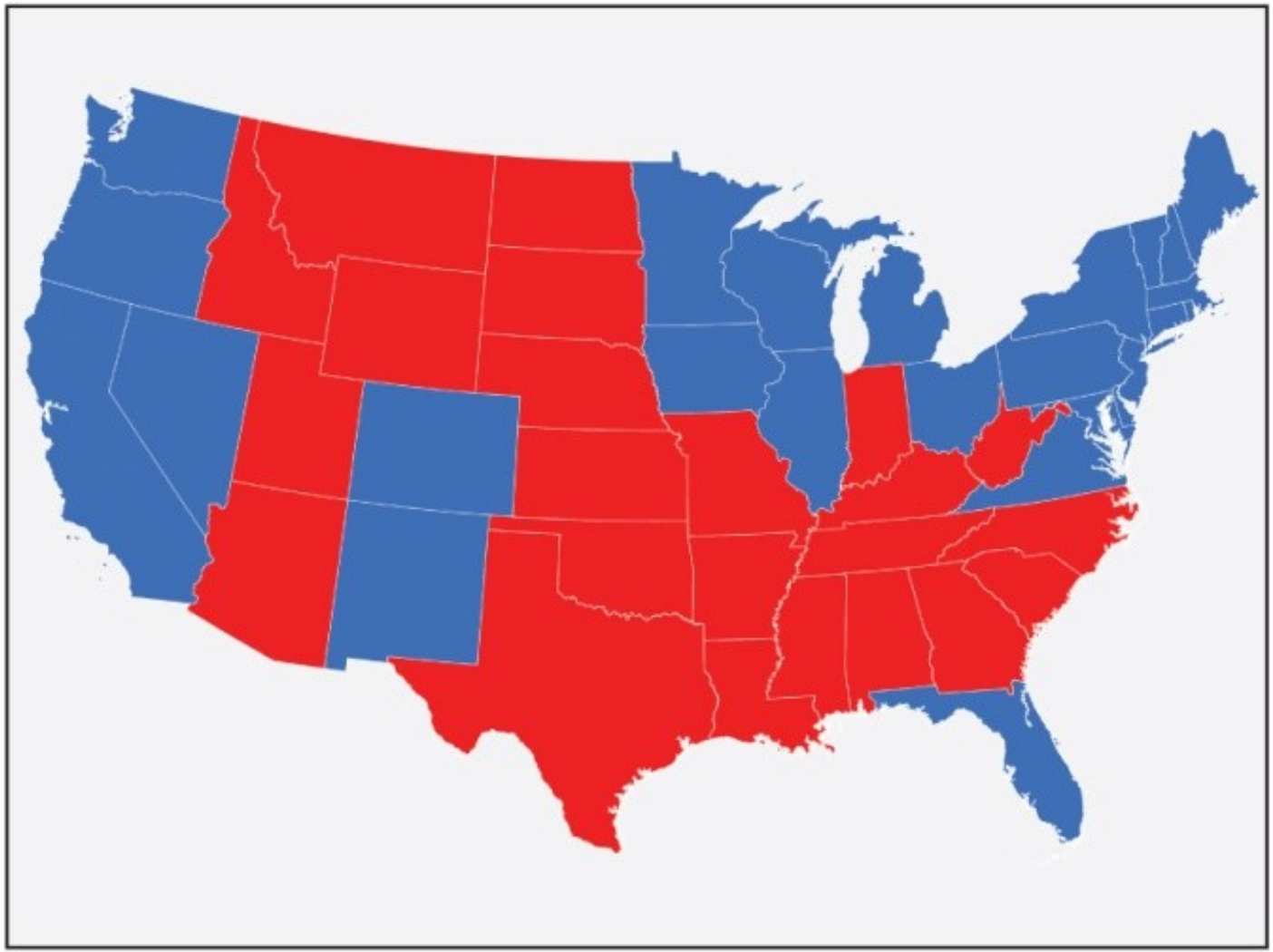
b)Population cartogram. Election results are shown



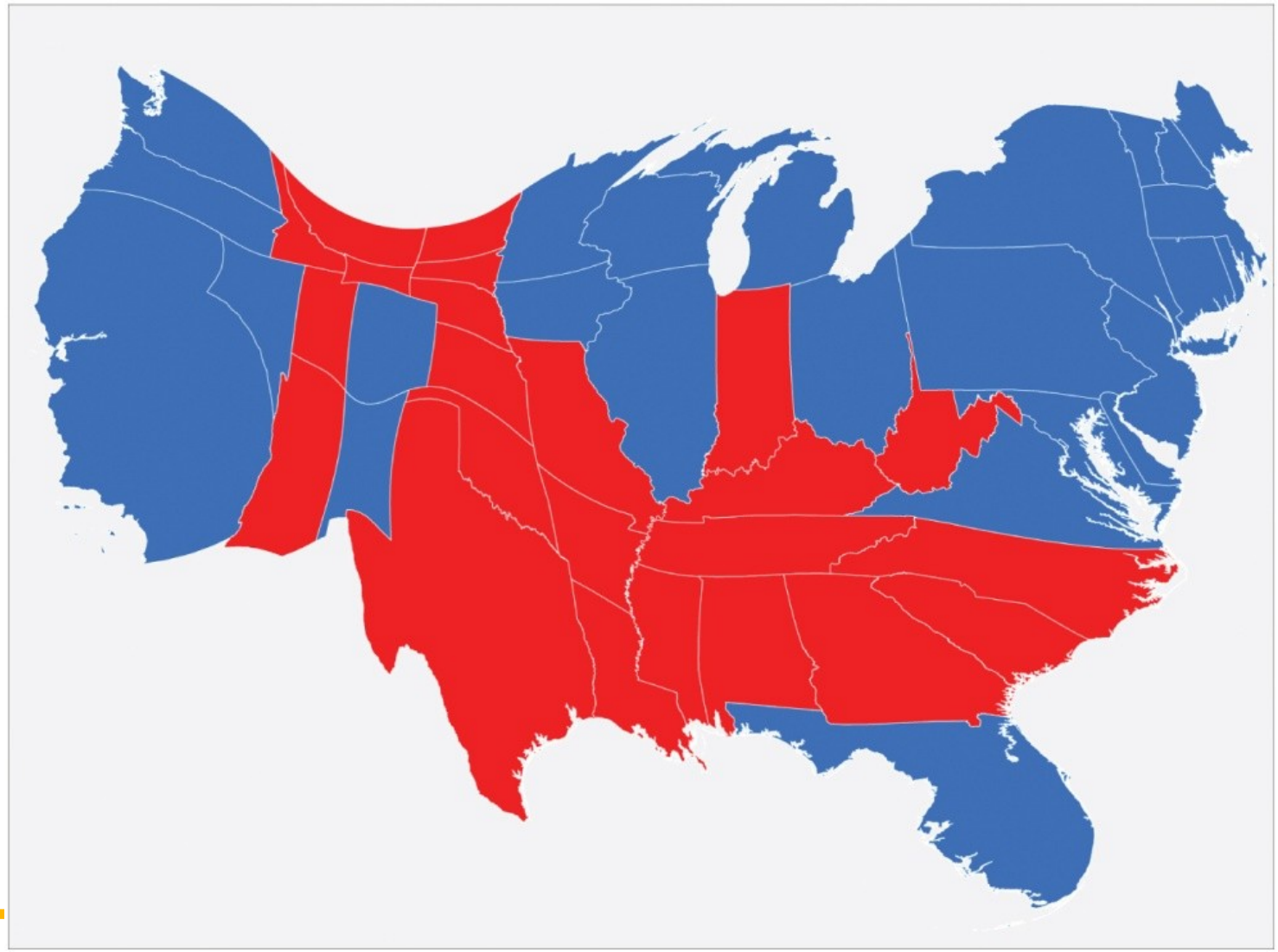


© McGraw Hill

**Conventional view.** This map of the November 2012 presidential election shows state-by-state results, colored red and blue to indicate Republican and Democratic majorities, respectively



**a)Population Cartogram**. Election results are shown on a cartogram where state sizes are based on population rather than land area.

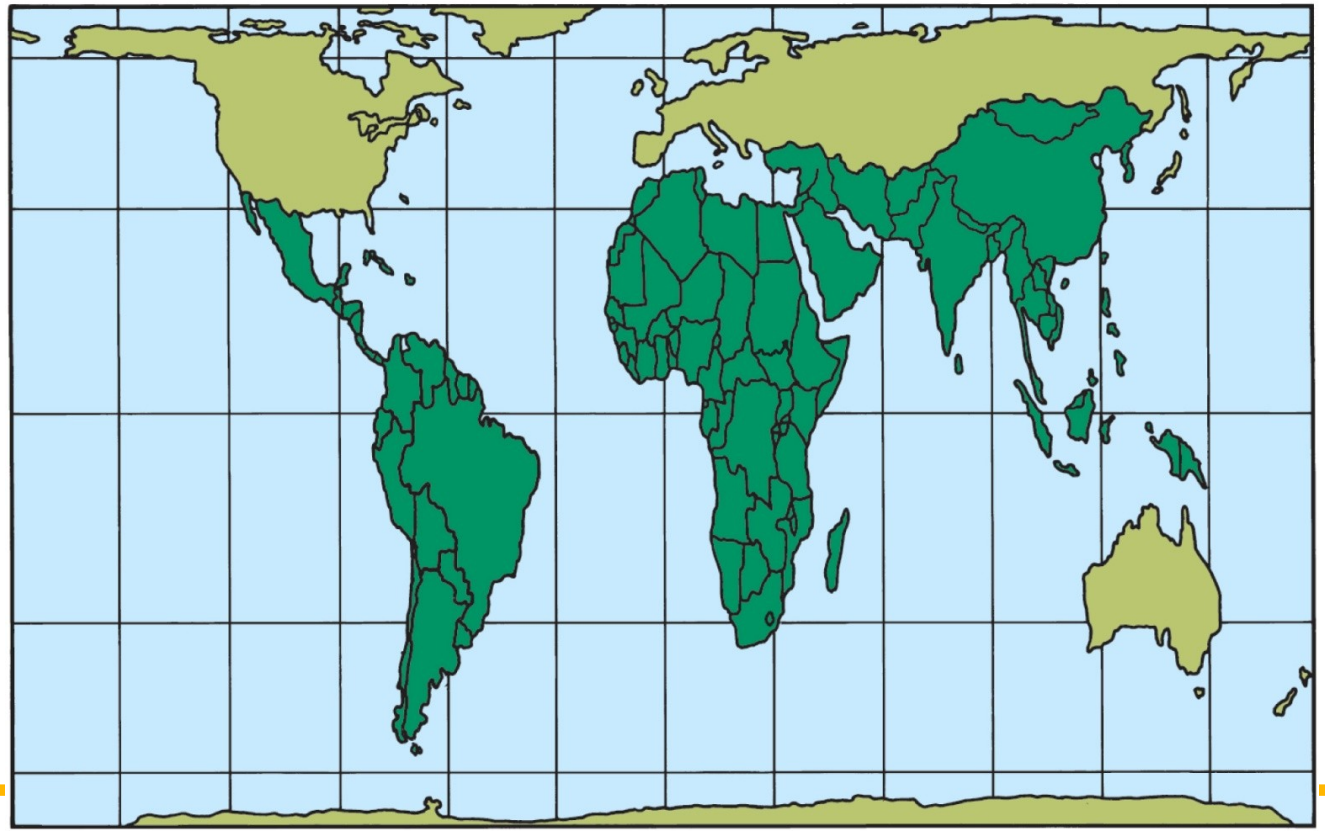


© McGraw Hill

## The Peters Projection

**A projection can be selected to emphasis or deemphasize certain ‘troubled areas of the world** i.e. Communist Russia

The **Peters projection badly distorts shapes in the tropics and at high latitudes.** Many equal-area projections yield a world map with less distortion.

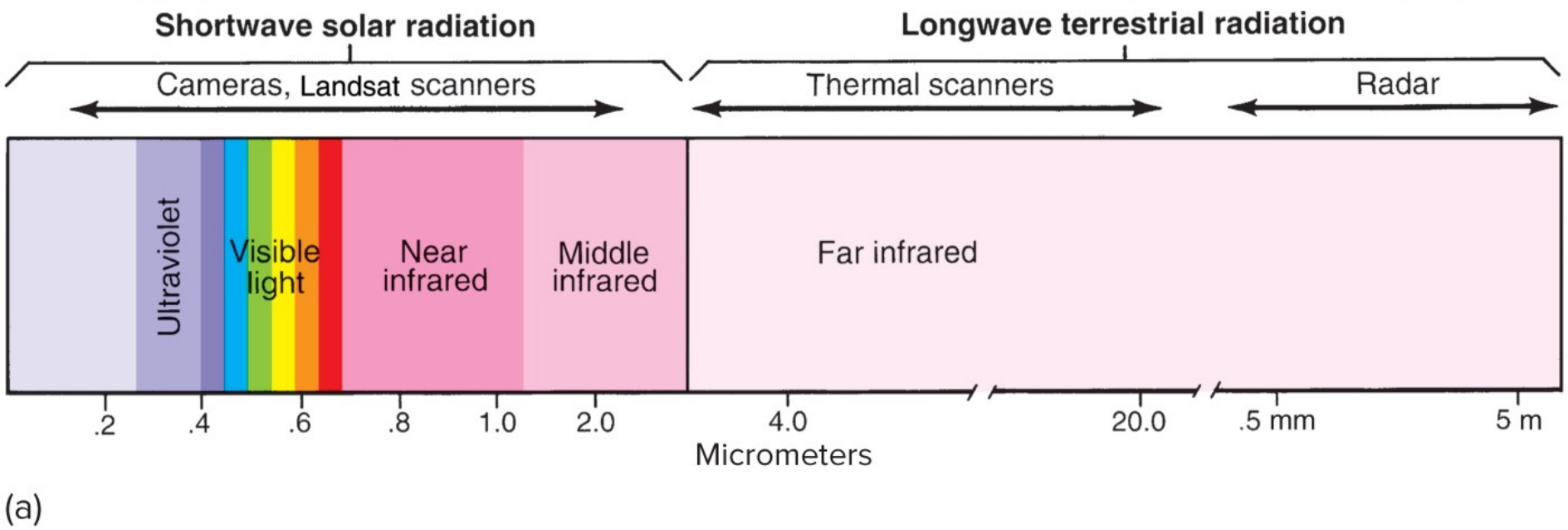


© McGraw Hill

# Contemporary Spatial Technologies

Two important technologies:

- **Remote Sensing: Passive**
- **Active/Sonar/Radio. light**
- **Global Positioning System (GPS)**




(a)

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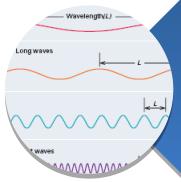

# 1. Electromagnetic Radiation

All surfaces emit radiation

- Hot objects – radiation in the form of **light**
- Cooler objects – **heat** radiation

Earth emits exactly as much energy as it absorbs from the sun – global **energy balance**

<u>Electromagnetic Radiation</u> – collection of energy waves, wide range of wavelengths, that travel away from the surface of an object.

***Wavelength*** *is the distance separating one wave crest from the next wave crest*

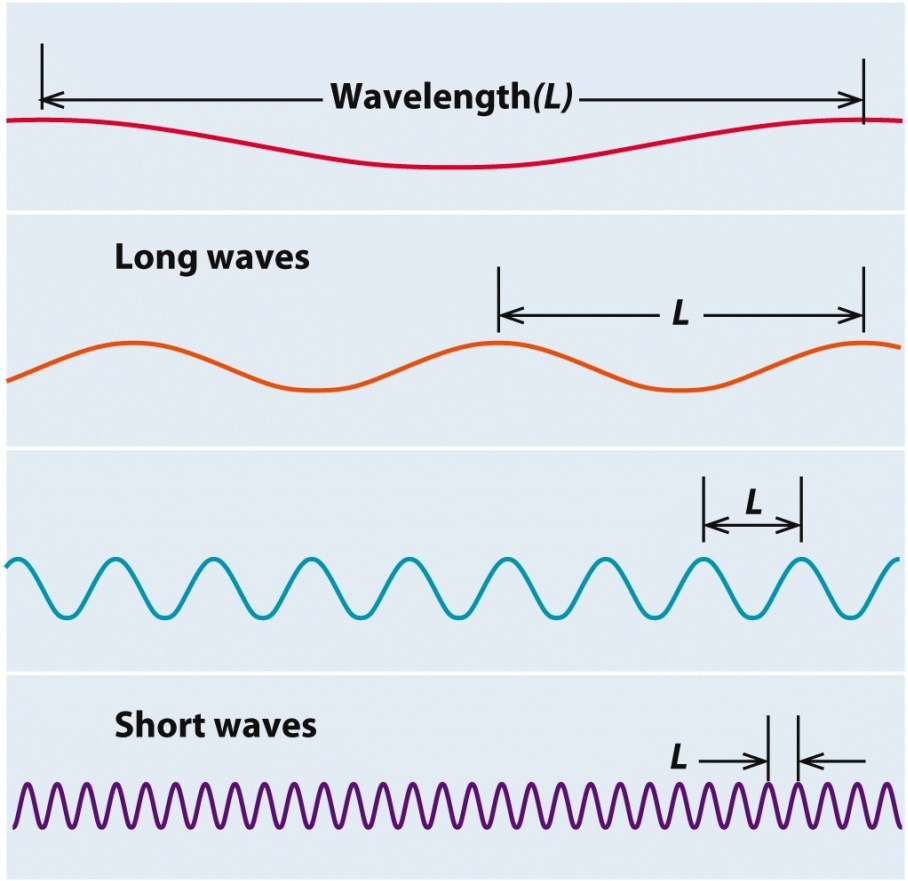


Figure 2.2

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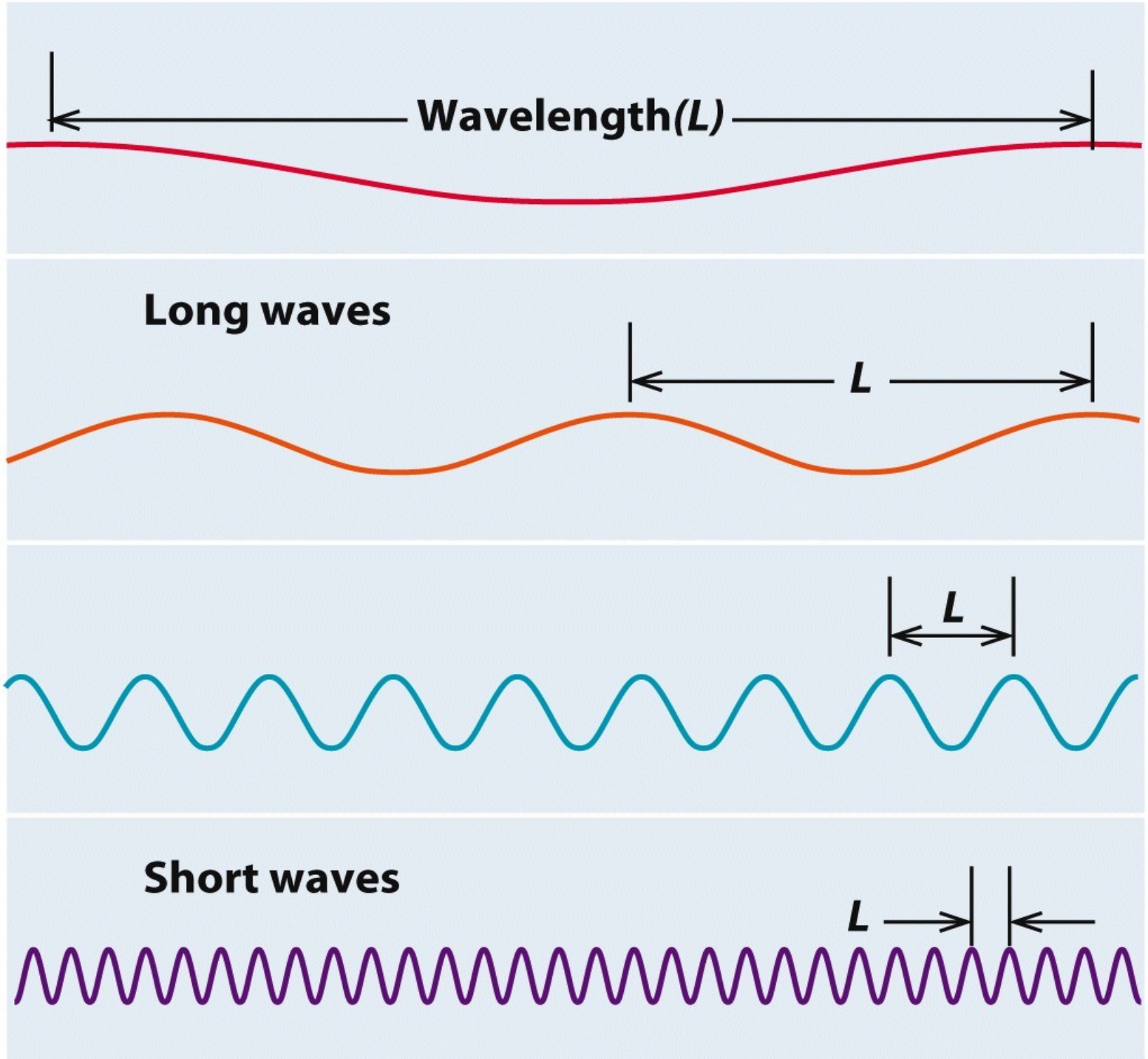


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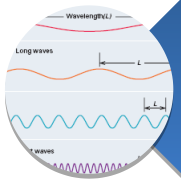

# 1. Electromagnetic Radiation

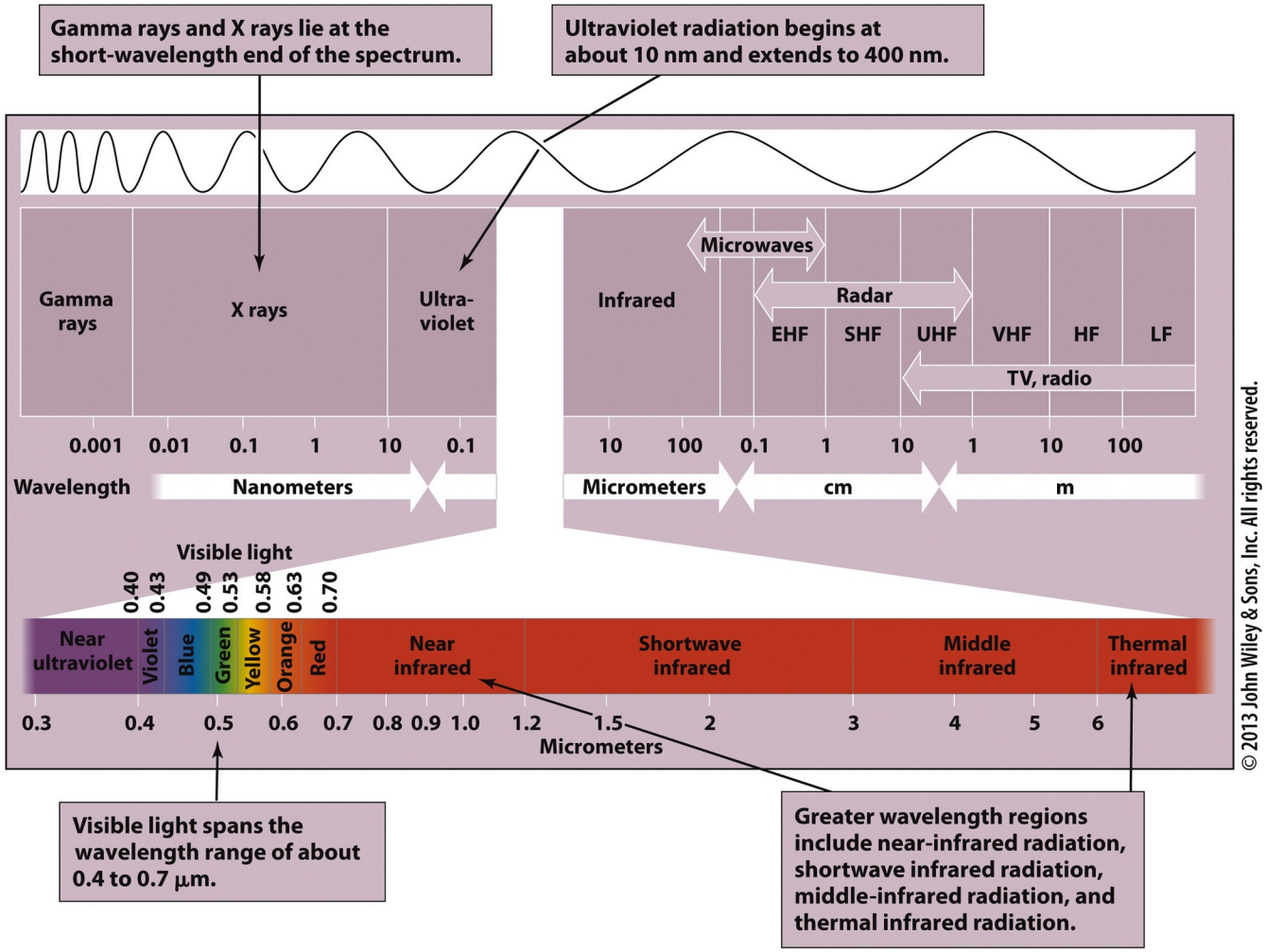


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Figure 2.3

1. Electromagnetic Radiation

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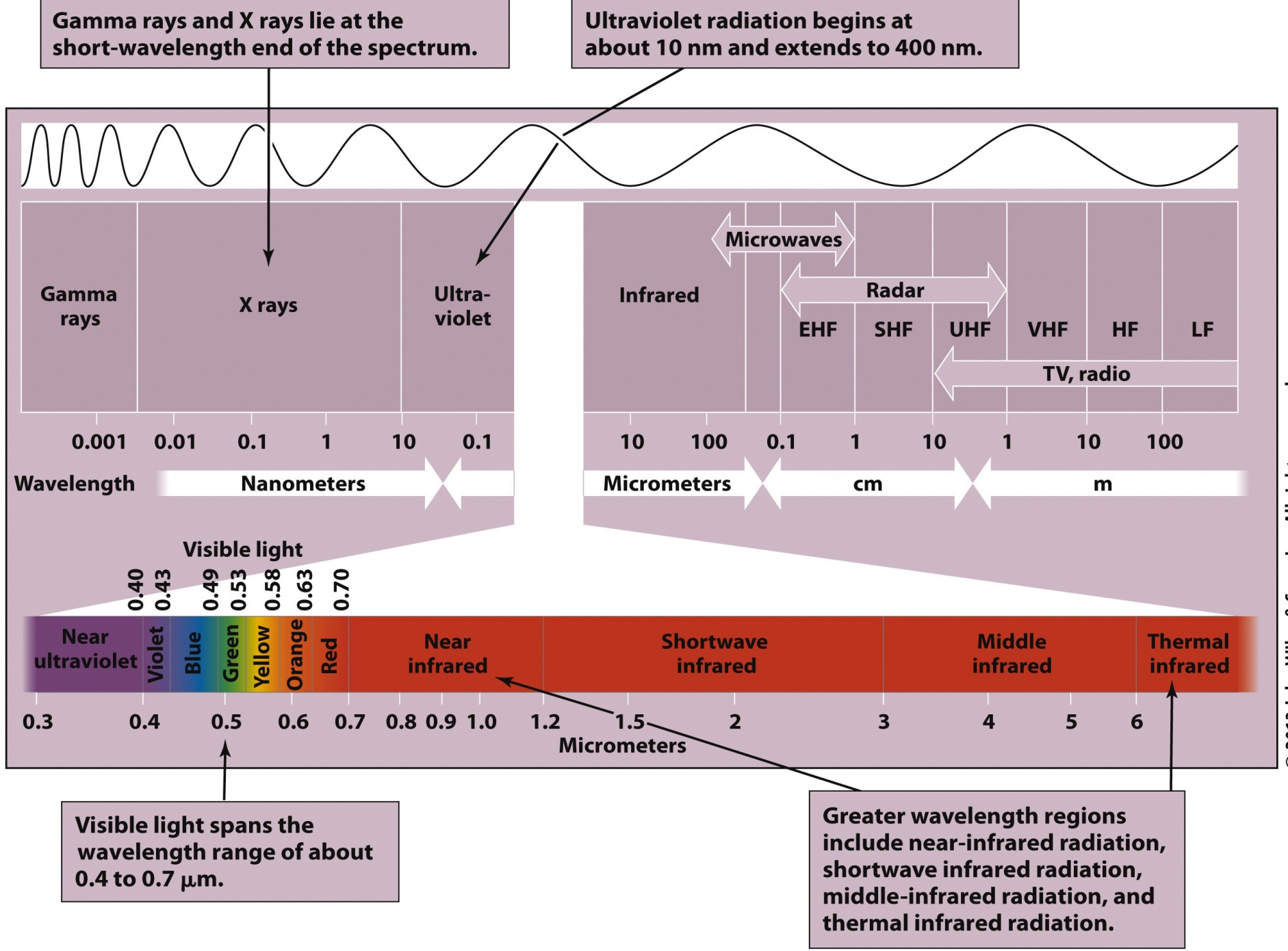


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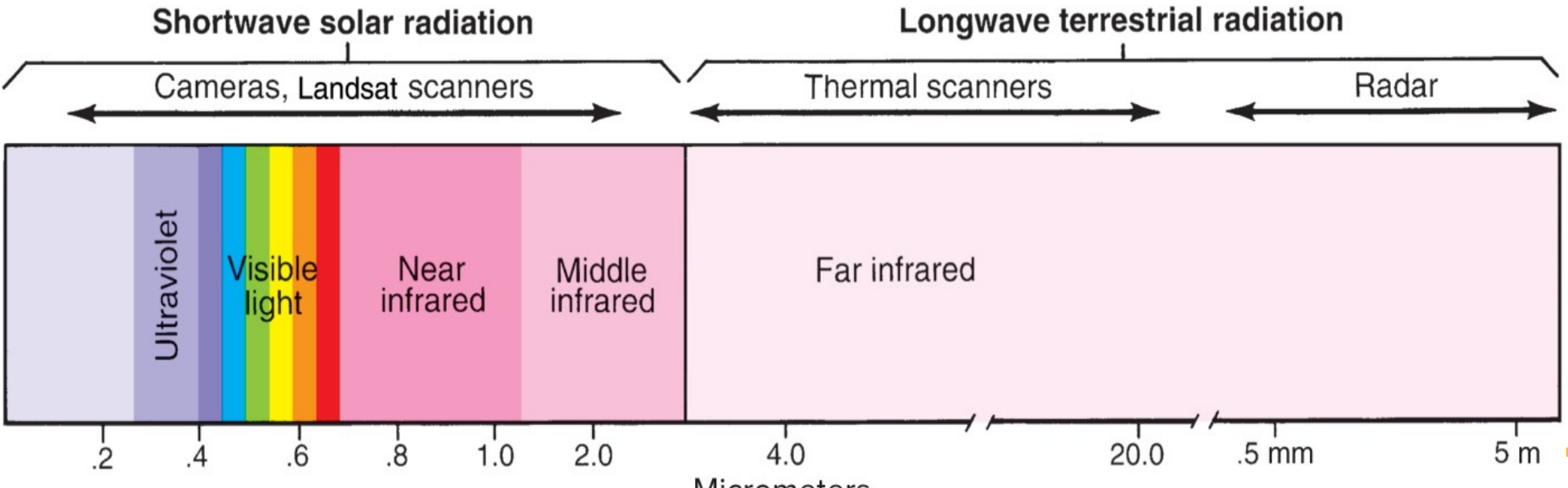
Figure 2.3

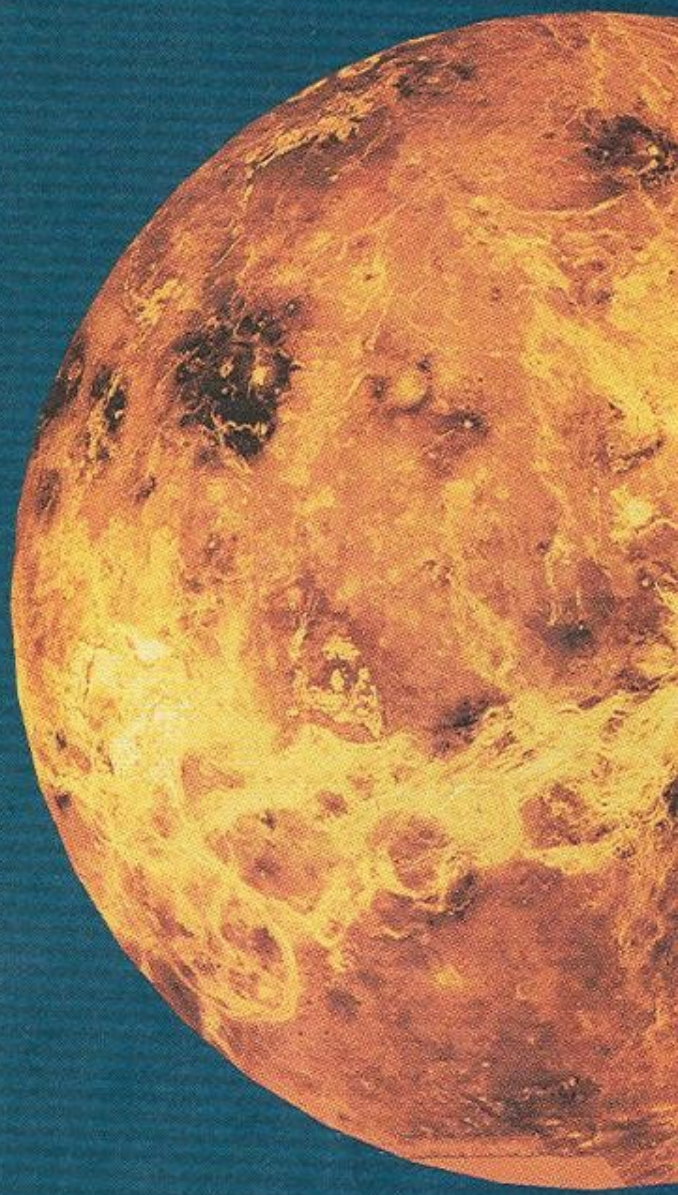
# Contemporary Spatial Technologies

a)**Wavelengths** of the electromagnetic spectrum in micrometers. One micrometer equals one-millionth of a meter. Sunlight is made up of different wavelengths. The human eye is sensitive to only some of these wavelengths, the ones we see in the colors of the rainbow. Although invisible, near infrared wavelengths can be recorded on special sensitized film and by scanners on satellites. The scanners measure reflected light in both the visible and near infrared portions of the spectrum. Wavelengths longe



# Venus Data

| | |
|---|---|
| Average distance from Sun: | 0.723 AU = 1.082 × $10^8$ km |
| Maximum distance from Sun: | 0.728 AU = 1.089 × $10^8$ km |
| Minimum distance from Sun: | 0.718 AU = 1.075 × $10^8$ km |
| Eccentricity of orbit: | 0.0068 |
| Average orbital speed: | 35.0 km/s |
| Orbital period: | 224.70 days |
| Rotation period: | 243.01 days (retrograde) |
| Inclination of equator to orbit: | 177.3° |
| Inclination of orbit to ecliptic: | 3.39° |
| Diameter (equatorial): | 12,104 km |
| Diameter (Earth = 1): | 0.949 |
| Mass: | 4.869 × $10^{24}$ kg |
| Mass (Earth = 1): | 0.815 |
| Average density: | 5240 kg/$m^3$ |
| Surface gravity (Earth = 1): | 0.91 |
| Escape speed: | 10.4 km/s |
| Average surface temperature: | 480°C = 900°F = 750 K |



# Contemporary Spatial Technologies: Remote Sensing

Detecting nature of an object and the content of an area without direct contact with the ground

## Aerial photography

- Standard photographic film
- Infrared film
  - False-color images

**Nonphotographic imagery**

- Thermal scanners
- Radar
- Lidar
- Satellites
  - Landsat satellites

(b)

b: U.S. Geological Survey

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# Contemporary Spatial Technologies: Remote Sensing

b)A color-infrared aerial photograph of Washington, D.C. (b) Source: U.S. Geological Survey.

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# Contemporary Spatial Technologies
## GPS (1) Global Positioning System

Network of satellites orbiting the earth that continuously transmit positions and time signals

- Maintained by the U.S. Department of Defense

## GPS receivers

- Record positions of multiple satellites simultaneously to determine latitude, longitude, altitude, time

Numerous applications, including:

- **Precision-guided weapons**
- **Navigation**
- **Mapping**
- **Environmental assessment**
- ***Einstein relativity effect***

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# Contemporary Spatial Technologies: GNSS [1] Global Navigation Satellite System

Network of satellites orbiting the earth that continuously transmit positions and time signals

- **GPS Maintained by the U.S. Department of Defense**

**GNSS receivers (GPS is US version)**

- Record positions of multiple satellites simultaneously to determine latitude, longitude, altitude, time.

**Numerous applications, including:**

- Precision-guided weapons.
- **Navigation.**
- **Mapping**.
- Environmental assessment.

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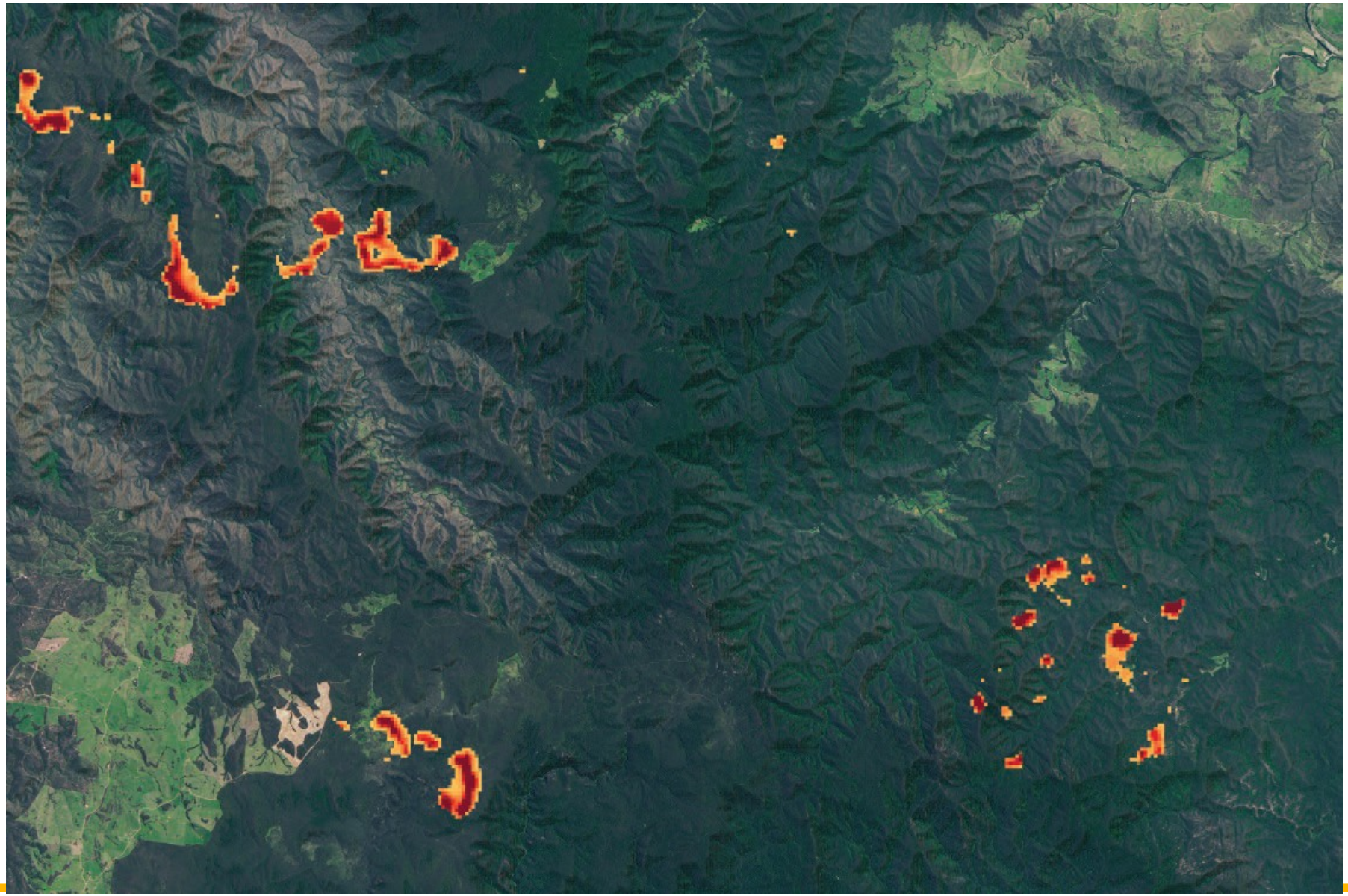
# hermal Radiation Images of Australian Wildfires



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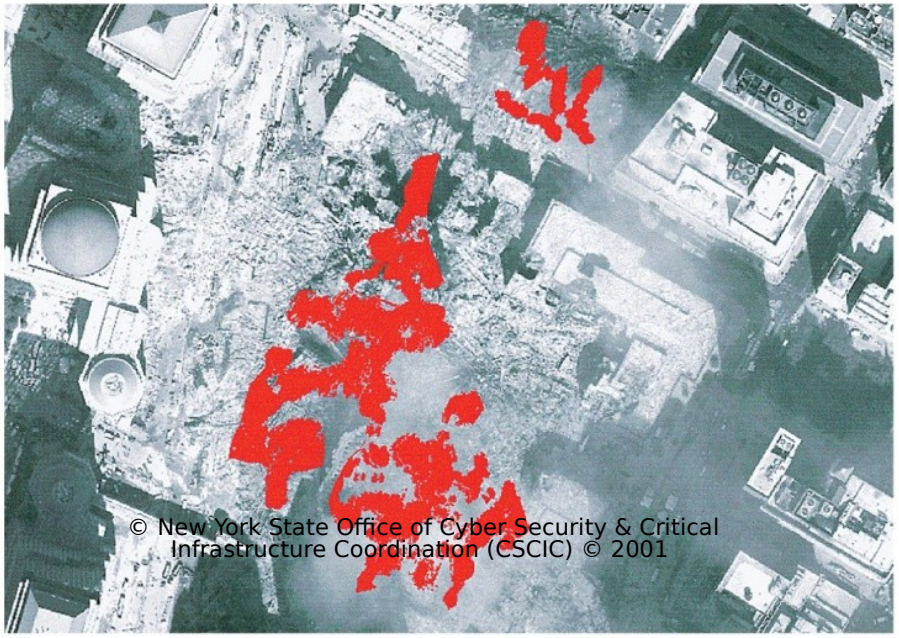
# Thermal Radiation Images of the World Trade Center site

Taken a few days after the attack and a month later




(a)

(b)

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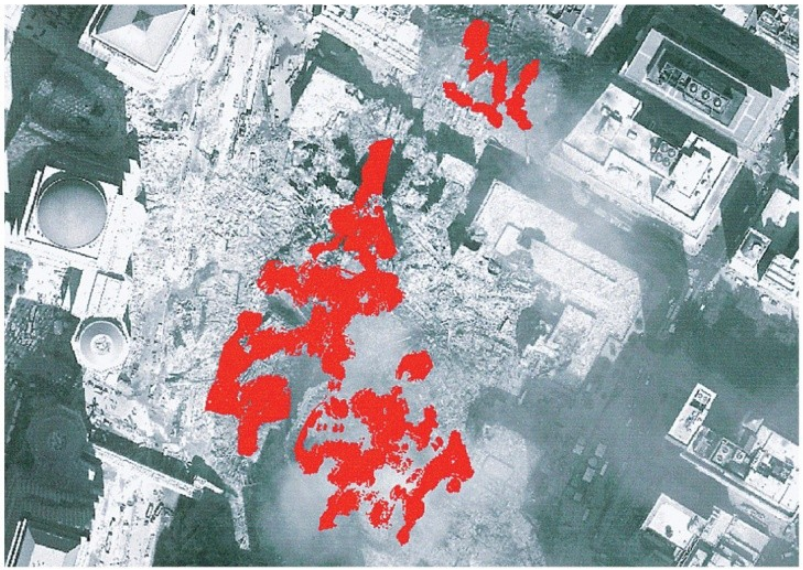
# Thermal Radiation Images of the World Trade Center site Long Description

Thermal radiation images of the World Trade Center site in New York City, 2001. Following the collapse of the twin towers on September 11, 2001, fire-fighting and rescue teams relied on daily thermal images of the site to detect fire patterns in the rubble and underground. Based on the patterns revealed, the teams decided where to work that day.

a) A few days after the attack, a nearly constant field of heat (shown in red) covered most of the 16-acre site.

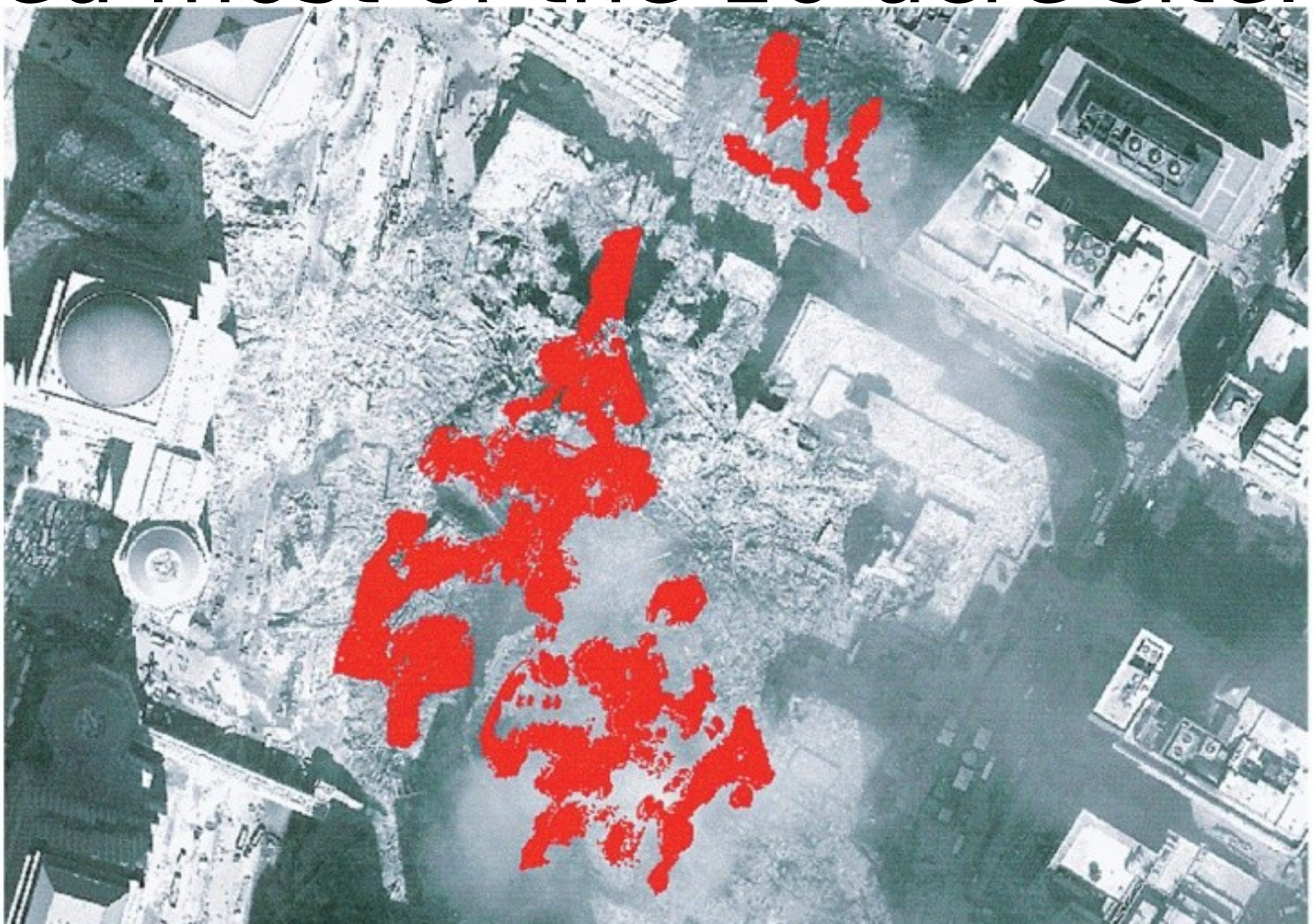
b) A month later, the underground blaze was confined largely to where the two towers once stood.



(a)

# assive Sensing: Signal is Received

a)A few days after the attack, a nearly constant field of heat (shown in red) covered most of the 16-acre site.



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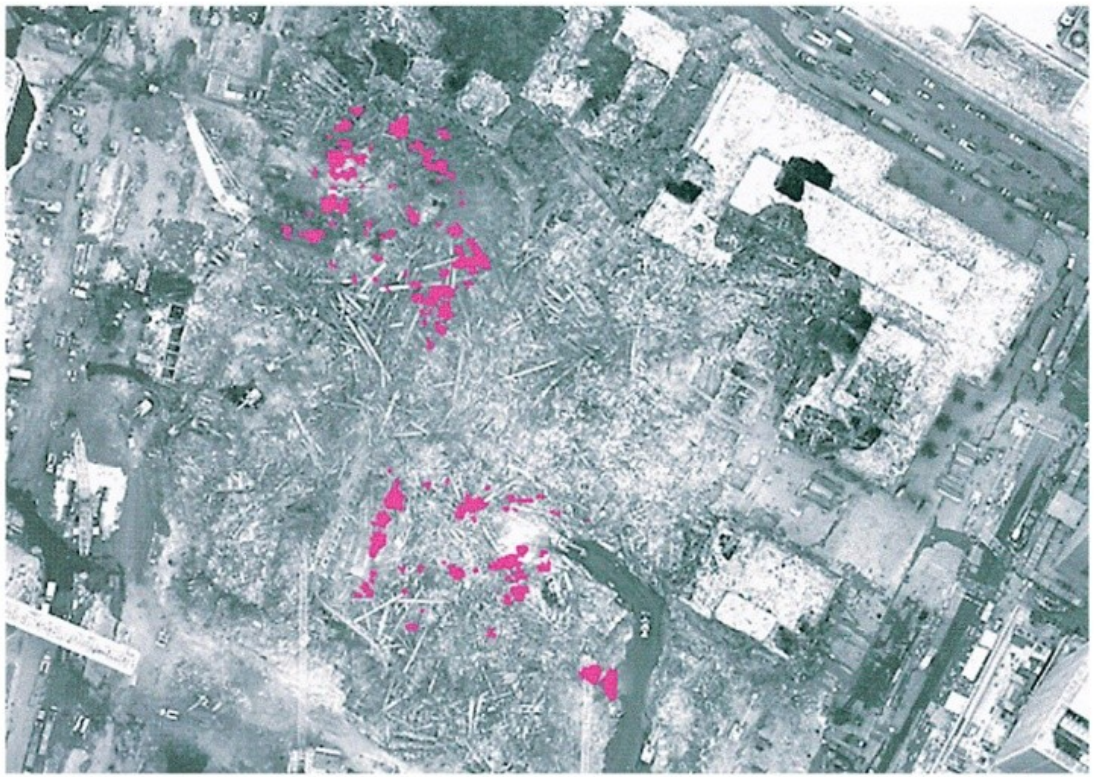
a)A month later, the underground blaze was confined largely to where the two towers once stood.



(b)

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# A SLAR mosaic of Los Angeles, California

## Active Sensing: A signal is emitted and received

NOAA/U.S. Army JPSD

# Contemporary Spatial Technologies: GNSS 2

GNSS receivers have become miniaturized and are available in all kinds of things from cell phones to dog collars to monitoring devices for criminals on probation

# Contemporary Spatial Technologies: Virtual and Interactive Maps

Maps are widely available on the Internet

## Google Earth

- Combines aerial photos, satellite images, and maps with street, terrain, and other data

Mashups

- Digital maps merged with data from other sources
- **Interactive mapping**

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# Integrating Technology: Geographic Information Systems (GIS) (1)

**Computer-based set of procedures for assembling, storing, manipulating, analyzing, and displaying geographically referenced data**

Five major components:

- Data input
- Data management
- Data manipulation
- Data analysis
- Data output

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# Integrating Technology: Geographic Information System (GIS) (2)

**First step** in developing a GIS is to create a **geographic database**

- Digital record of geographic information from:
  - Maps, surveys, aerial photos, satellite images, etc.
- Every item in database is **tied to a precise geographical location**
- Purpose of study determines data

**Second step** is **spatial analysis** (manipulating, analyzing and displaying data with speed and precision not otherwise possible)

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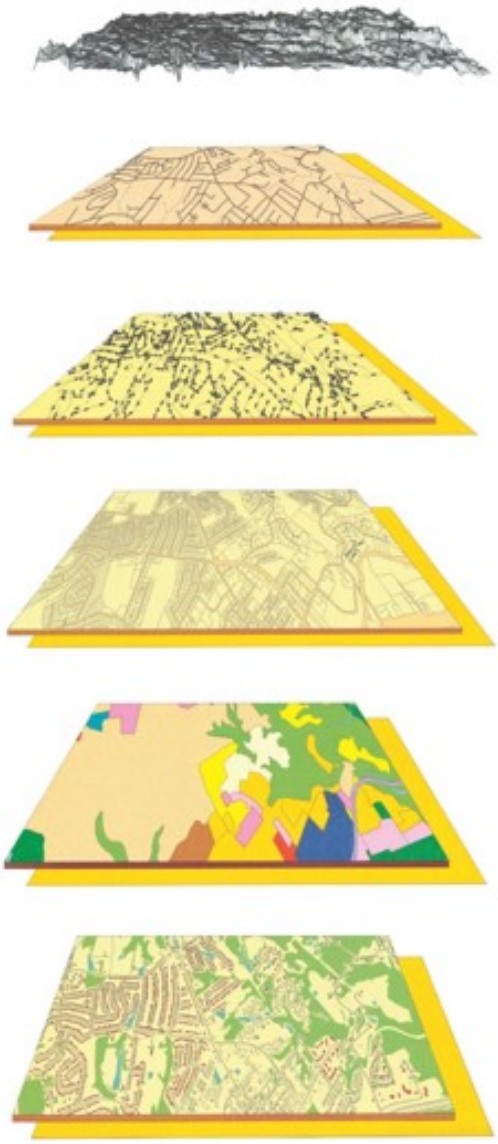
# Integrating Technology: Geographic Information Systems (GIS) (3)

**Last step** is data **output** in the form of a map as a **display** on a computer monitor or provided as a **hard copy**.



**Terrain Models**

**Network**
- Street centerlines
- Drainage network

**Utilities**
- Sanitary sewer lines
- Water lines
- Telephone
- Gas/electric

**Lots/Ownership**
- Lot lines
- Property lines

**Zones/Districts**
- Comprehensive plan
- Municipal zoning
- Voting precincts
- School districts
- Census tracts/blocks

**Base Mapping**
- Road pavement
- Buildings/structures
- Fences/parking lots
- Drainage
- Wooded areas
- Spot elevation
- Contour lines
- Recreational facilities

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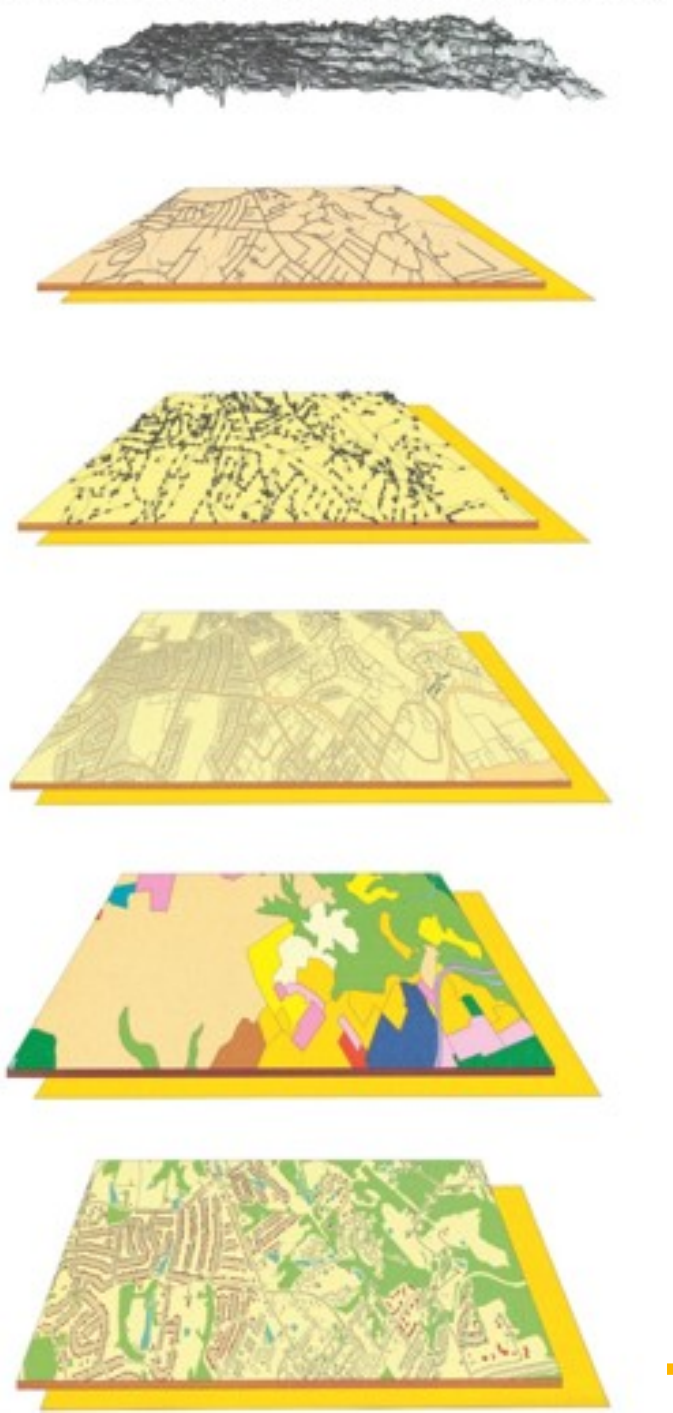

# Terrain

**Network**
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**Utilities**
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**Base Mapping**
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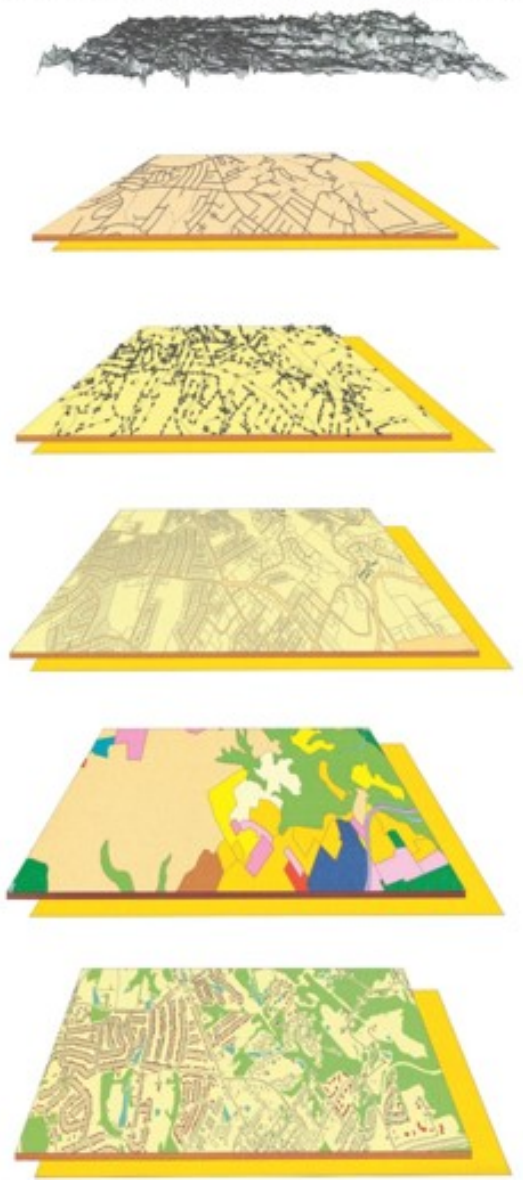
- Recreational facilities

# Integrating Technology: Geographic Information Systems (GIS) (3)

A model of a **Geographic Information System.** ***Information layering*** is the essence of a **GIS**. Map information that has been converted to digital **data is stored** in the computer in different **data "layers**." A GIS enables the user to **combine just the layers that are desired to produce a composite map** and to **analyze how those variables relate to one another.** In this example, the different layers of information are to be used in different combinations for city planning purposes. What sorts of layers might you need if you were asked to locate a



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# Integrating Technology: Geographic Information Systems (GIS) (4)

## Applications of GIS

- Various fields for a variety of purposes, including:
  - Biologists and ecologists: studying **environmental problems**
  - **Epidemiologists**: studying diffusion of diseases and entomological risk factors
  - Political scientists: evaluating legislative **districts**
  - Sociologists: examining patterns of segregation
  - Private sector companies: **site selection**, analyzing sale territories, calculating optimal driving routes
  - Government: transportation planning, analyzing patterns of crime, **responding to disasters**

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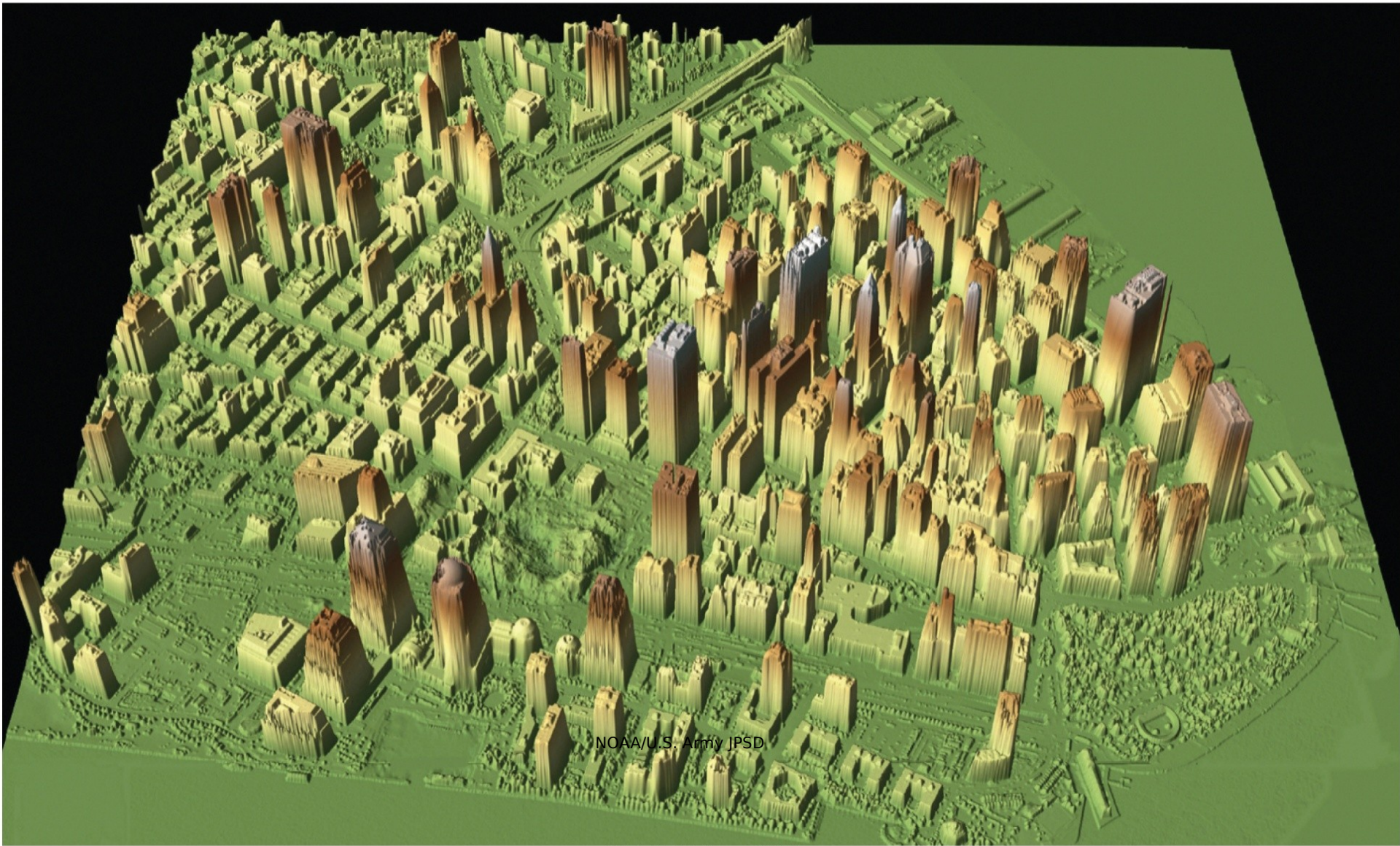
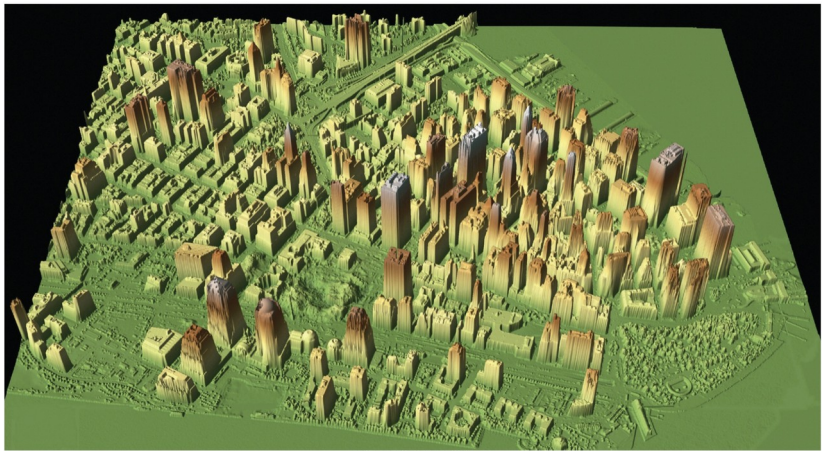
# A Three-dimensional Lidar Image of the Site of the World Trade Center



# A Three-dimensional Lidar Image of the Site of the World Trade Center Long Description



A **three-dimensional lidar image of the site of the World Trade Center.** Accurately mapping the wreckage of the World Trade Center using a combination of remote sensing, **GPS, and GIS was invaluable in recovery and cleanup efforts after the attacks** of 9/11. The GPS system was used to position both ground and airborne mapping sensors. Aircraft outfitted with three kinds of sensors collected high-resolution aerial photography, thermal imagery, and lidar (light detection and ranging) data. **Within hours after the data were collected, GIS professionals from government, industry, and academia merged the digital data to produce large, high-resolution images of the building structures** and the surrounding area. The **three-dimensional models** created by the lidar system **enabled engineers to calculate the volume of the rubble piles, track their movement and change, and determine the reach needed by cranes to remove** them. Source: NOAA/U.S. Army JPSD.

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